SURVEY OF BAT ROOSTS IN SOME PRIMARY AND SECONDARY SCHOOLS AND THE ATTITUDES OF STUDENTS TOWARDS BATS IN ZARIA, NIGERIA

BY

AKILU ISMA'IL

DEPARTMENT OF BIOLOGICAL SCIENCES,
FACULTY OF SCIENCE,
AHMADU BELLO UNIVERSITY, ZARIA
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BY

Akilu ISMA'IL, B.Sc (ED) Biology (A.B.U., 2010)
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DEPARTMENT OF BIOLOGICAL SCIENCES,
FACULTY OF SCIENCE,
AHMADU BELLO UNIVERSITY, ZARIA
NIGERIA

OCTOBER, 2015

DECLARATION

I declare that the work in this thesis entitled “Survey of Bat Roosts in Some Primary and Secondary Schools and the Attitudes of Students towards Bats in Zaria, Nigeria” was carried out by me in the Department of Biological Sciences. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was previously presented for another degree or diploma at this or any other institution.

AKILU ISMAI’IL _____ _____

Signature Date

CERTIFICATION

This research thesis titled "SURVEY OF BAT ROOSTS IN SOME PRIMARY AND SECONDARY SCHOOLS AND THE ATTITUDES OF STUDENTS TOWARDS BATS IN ZARIA, NIGERIA" by AKILU ISMA'IL meets the regulations governing the award of degree of Master of Science (M.Sc.) of Ahmadu Bello University, and is approved for its contributions to knowledge and literary presentation.

Dr. I.M.K. Gadzama _____ _____

Chairman, Supervisory Committee Signature Date
Department of Biological Sciences,
Ahmadu Bello University, Zaria

Prof. S. P. Bako _____ _____

Member, Supervisory Committee Signature Date
Department of Biological Sciences,
Ahmadu Bello University, Zaria

Prof. A. K. Adamu _____ _____

Head of Department Signature Date
Department of Biological Sciences,
Ahmadu Bello University, Zaria

Prof. Kabir Bala _____ _____

Dean, School of Postgraduate Studies Signature Date
Department of Biological Sciences,
Ahmadu Bello University, Zaria

DEDICATION

To the loving memory of my late parents who toiled day and night to send me to school and gave me an opportunity they never had.

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ABSTRACT

A survey on the presence of bat roosts, associated nuisances and the attitudes of students towards bats in some public primary and secondary schools in Zaria metropolis was conducted between Augusts and November, 2014. Bat roosts and the associated damages/nuisances were identified through internal and external inspections. A total of 384 school children were self-administered with questionnaire to assess their knowledge and attitudes toward bats. The questionnaire contained 13 questions on bat's factual knowledge and 21 items based on Kellert's attitude typology. The overall survey indicated that twenty one constituting 28% of the 75 schools within Zaria metropolis had roosting bats during the time of the surveyed. The numbers of bats per school ranged from 3 to 322+, and are found to emerge from their roosts at about of 20 minutes after sunset. Schools with colony of roosting bats experienced nuisances such as distracting noise, stains, droppings, odour and damage ceilings that could affect health, safety, and learning opportunities of school children. Out of the 384 questionnaires administered to participants, 376 (97.9%) were returned and filled. The results showed that respondents were aware of bats potential to disease transmission but the factual knowledge percentage scores on the biology and ecological roles of bats were low. The negativistic attitude type ranked first, followed by aesthetic, ecoscientistic, moralistic, dominionistic, utilitarian and naturalistic. Both the knowledge of, and attitudes toward bats were significantly ($P<0.05$) influenced by gender and level of education among the school children in Zaria. Girls lacked knowledge of bats than the boys, and showed more negativistic attitude. All the attitudinal sub-measures significantly decreased with increased level of education, with the exception of utilitarian sub-measure. The pre-test and post-test (n=180) revealed

significant change ($P<0.05$) in respondents' attitude in favour of bats conservation as a result of knowledge gain. It is concluded that colony of roosting bats in schools caused a considerable nuisance, and that there was a link between factual knowledge of bats and children attitudes towards them. It is recommended that environmental education packages such as posters and handbills that contain bats factual knowledge be provided to schools that still harbour bats.

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List of Abbreviations

BCT - Bats Conservation Trust

IUCN - International Union for the Conservation of Nature

LGEA - Local Government Education Authority

BCI - Bat Conservation International

ABC - African Bat Conservation

JSS - Junior Secondary School

SSS - Senior Secondary School

LGEA - Local Government Education Authority

UBE - Universal Basic Education

P.S - Primary School

GSS - Government Secondary School

GGSS - Government Girls Secondary School

CHAPTER ONE

1.0 INTRODUCTION

Bats are the second most diversed among mammalian orders, this implies great physiological and ecological diversity (Messenger *et al*., 2005), and have evolved incredibly rich diversity of roosting and feeding habits. They form one of the largest non-human aggregations and the most abundant groups of mammals when measured in numbers of individuals (Goodsman *et al*., 2008). They evolved before 52 million years ago and diversified into more than 1,232 extant species (Racey *et al*., 2010). Bat populations appear to be declining, presumably in response to anthropogenic activities like habitat destruction and fragmentation, disturbance to caves, depletion of food resources, overhunting for bush meat and persecution, increased use of pesticides, infectious diseases, and wind energy turbines (African Bat Conservation (ABC), 2013). As natural roosting sites have become scarce due to development and land use changes, bats are now depending on houses, schools, bridges, mines and barns as their roosting sites (Hudt, 2012). These man-made roosts can provide stable micro-climates for the bats. Loss of natural roosts has increased the importance of man-made structures for bats to the point that they are becoming essential in the survival of many bat species. However, even these man-made roosts are now under threat of human negative attitudes, demolition of old buildings, renovations, changes in use and artificial lighting (Bat Conservation Trust (BCT), 2007).

Although bats are among the most overlooked in spite of their economical and ecological importance, their conservation is mandatory (Hudt, 2012). As regional urbanization

increases, so do interactions between humans and wildlife (Kunz and Reynolds, 2003). Where previous habitat has been reduced due to urbanization and development, a few bat species that easily adapt to new environments now roost in homes and buildings (Kunz and Reynolds, 2003).

Roosts protect the bat from predators and inclement weather. Bat roosts may be located at a considerable distance from the foraging area (Bradbury, 1977). The abundance of bats populations could depend on the availability of suitable roosting sites and lack of disturbances (Noromanpiandra *et al.,* 2010). Roosts provide sites for social interactions, mating, rearing of offspring, hibernation, and protection from predators and changing weather conditions (Kunz, 1982).

In schools, a range of possible roosting opportunities exist that mimic those found in the natural environment. Crevice-like or tree-cavity type spaces in school buildings include fascia and barge boarding, spaces beneath roof tiles, wall coatings, hollow joints, rain gutters and chimneys (Hudt, 2012). Cave-like spaces include attics and cellars that are dark, exhibiting stable temperatures and humidity (BCT, 2007). School buildings also have little or no disturbances when compared with residential buildings.

Although species are fundamental units in conservation, practically all threats which affect the animal species included in the International Union for the Conservation of Nature (IUCN) Red List (IUCN, 2013) are directly or indirectly associated with anthropogenic activities. This scenario represents a challenge in the quest for ways to exploit animal resources while at the same time minimizing the impact on animal species and it is evident that conservationists must understand not only the ecological, but also

the cultural and economic interactions that link ecological and social systems into a common regional system, as well as understand the feedback that governs these interactions (Mulo and Alves, 2014).

Conservation of biodiversity not only requires effective measures, such as the establishment of protected areas, legal regulations for the use of natural resources, and the control of introduced species, but also requires the dissemination of public information and education about native organisms, their values and the consequences of human activities on local biodiversity (Barner, 2013). Achievements of conservation projects could improve if communication and biodiversity education are incorporated into the components of their design. This will help in improving positive attitudes of the public towards wildlife conservation, as the attitudes and values of an individual person are the fundamental building block of a society's power to evoke a change (Barner, 2013). This indicates that, the collective attitudes and values of society can determine the success or failure of a conservation intervention (Barner, 2013) and wide consensus exists that human attitudes and behavior toward nature must be understood and often influenced in order to avoid further loss of biodiversity (Bjerke, 1998).

Attitudes toward particular groups of animals, or even toward a single species, often function as an element in relatively intense and complex conflicts between different human groups over natural resource issues (Kellert, 1991; Reading and Kellert, 1993; Bjerke and Ostdahl, 2004). Several studies have demonstrated that attitudes toward animals differ between groups delineated by demographic and socioeconomic variables (Kellert, 1996).

Primary and secondary school students are one of the important groups that can be used in promoting conservation of wildlife, because they are in the stage of attitudes and also they, are future decision-makers. Therefore, building positive attitudes in them is necessary for increasing the pro-environmental behaviour of future citizens (Prokop and Kubiatko, 2008).

Conservation education is an integral part of the conservation of native species (Jacobson *et al*., 2006) and has been successfully shown to change people's knowledge of, and attitude towards, a host of different organisms (Zimmerman, 1996). According to Udeni (2013) conservation education is taught in Nigerian schools through Basic Science and Biology subjects at junior and senior secondary school levels respectively. Before entering secondary school, primary school pupils in Nigeria knew nothing on conservation and natural resources between Class 4 - 6 (pupils aged 9 - 12) in primary schools through Basic Science subject (Udeani, 2013). However, bat species are rarely mentioned in their syllabus.. At secondary school level, the biology curriculum covers topics like interactions between organisms, energy cycles, biodiversity, protected areas and endangered species Udeani (2013). These topics are aimed at conservation and wildlife appreciation.

1.1 Statement of the Problem

In Zaria, bats natural roosting sites appear to be declining in numbers, presumably due to change in their habitat, which involve felling of trees, bush fires and construction of houses. The hitherto biggest colony and abode of bats which used to be the Zaria

Railways Quarters, Anguwan Iya (Usman, 2010), some parts of GRA area and Kofan Gayan Low-cost Quarters (G, Sadauki, personal communication, 2014) witnessed massive felling of trees and renovation/construction of buildings which has decimated the bat populations, hence increasing their dependence on man-made structures that meet their thermoregulation and security needs. Despite the apparent high occupancy rate of bats in human dwellings, previous studies mostly focus on bat taxonomy and ecology (Noromanpiandra *et al.*, 2010), and little is known about their roosts and the potential problems they cause on property they occupied within our locality.

Considering their nature in terms of level of human disturbances and availability of accessible large roof voids with unobstructed flying spaces, schools in Zaria could offer a range of possible roosting opportunities for bats. Presence of active bats within school environment can have several economic and aesthetic benefits (BCT, 2007), however, given the wrong set of circumstances, bat species can become a nuisance. Building infestation by bats constitutes a serious public health problem (Greenhall, 1964). They spoil food and make ceilings, walls, and floors dirty with the accumulation of guano and urine (Greenhall, 1964). Besides being providers of many ecosystem services such as control of arthropod populations, pollination, and seed dispersal (Kelly, 2012), sixty six viruses have been isolated from bats (Calisher *et al.*, 2006). Some of these viruses include Ebola, Hendra, Coronavirus. These, among others, provide challenges to bat population persistence in human dominated areas.

The children's interest in, ideas about and engagement with wild animals residing in human dominated areas, such as bats, has been largely misconstrued. Bats are often

feared, hated and persecuted (Thomas, 2011). The recent outbreak of Ebola disease in some countries of West Africa has further increased the negative attitudes and perceptions held by people toward bats. Therefore, the mare presence of bats in a school building can be beyond tolerance of school children and teachers, most of whom are unaware that bats provide invaluable services to the environment. These, among other factors, provide conservation challenges, particularly for bats living in buildings**.**

These situations emphases the need to identify schools with bat roosts, the associated nuisances and also educate school children on the reasons for bat conservation and why it is important to use safe, non destructive methods to alleviate conflicts between humans and bats.

1.2 Justification

The result of this study will provide quantitative information on bat roosts that exist within public primary and secondary schools environment and the associated nuisance/health risks and the characteristics of schools preferred by bats for roosting in Zaria.

Cohen (1973) and Bradley *et al*. (1999) found that group of students with more environmental information shows different attitudes than the group with less environmental information. Therefore, the study will also provide information about school children's knowledge and attitude toward bats in relation to gender and level of education, and the role education play in changing children' attitudes towards bats.

1.3 Aims

The aim of this study was to survey bat roosts in public primary and secondary schools and to assess the attitudes of students towards bats in Zaria.

1.4 Objectives of the Study

The objectives of the study were to:

i. Identify public primary and secondary schools with bat roosts within Zaria metropolis.
ii. Document nuisance or structural damage associated with the bat roosts in the public primary and secondary schools they occupied in Zaria.
iii. Determine the knowledge and attitudes of school children in relation to gender and level of education (Class in school) toward bats.
iv. Evaluate the role of educational unit on bats on school children's attitudes towards bat conservation in Zaria.

1.5 Research Hypotheses

i. There are no bat roosts in public primary and secondary schools within Zaria metropolis.
ii. Bats do not pose any nuisance or structural damage in public primary and secondary schools they occupied in Zaria.

iii. There is no significant difference between knowledge of, and attitudes towards bat among school children in relation to gender and level of education.

iv. There is no significant difference in the knowledge gained and attitude improvement among school children towards bat in Zaria.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Bats Biology, Reproduction and Behaviour

The Order Chiroptera is divided into two suborders, the Megachiroptera and the Microchiroptera (Koopman, 1993). The megachiropterans are all found in the Old World tropics and sub-tropics, feed on fruit, nectar and pollen and roost mainly in trees (Duncan and Chapman, 1999). There is one family, the Pteropodidae, containing 42 genera and 166 species (Koopman, 1993). The 57 species of the largest genus, *Pteropus*, are mainly island species, and levels of endemism are extremely high; 35 species are found on only one, or on a small group, of islands (Mickleburgh *et al.*, 1992). The megachiropterans do not use high-frequency echolocation but have large eyes and good vision, and use sight and smell as their major locational senses. The microchiropterans are found almost world-wide and there are 16 families, 135 genera and 759 species (Koopman, 1993). Microchiropterans use high-frequency echolocation and rely on hearing as their major locational sense. They may feed on insects, fruit, nectar, pollen, fish, other vertebrates, or blood and they roost in a great variety of sites including caves, buildings and trees (Duncan and Chapman, 1999). The largest family, the Vespertilionidae, has about 300 species and an almost global distribution.

Bats generally mate in the raining and harmattan seasons, but the female retains the sperm in the uterus until spring, when ovulation and fertilization take place. Pregnant females may congregate in maternity colonies in buildings, behind chimneys, beneath

bridges, in tree hollows, caves, mines, or other dark retreats (Koopman, 1993). No nests are built.

Pregnancy lasts between six and nine weeks. The length of the pregnancy depends on the species and can be influenced by weather, climate and availability of food. Bats usually give birth to a single baby (called a pup) each year (Koopman, 1993). They keep their babies close and nurture them carefully. The young bats are suckled by their mothers for four to five weeks until they are old enough to fly. They then begin to venture out from the roost to forage for food. Bats often live more than 10 years (Koopman, 1993).

Bats are nocturnal and are active at twilight. A large portion of bats migrate hundreds of kilometres to winter hibernation dens, some pass into torpor in cold weather, rousing and feeding when warm weather allows for insects to be active. Others retreat to caves for winter and hibernate for six months (Kunz and Lumsden, 2005). Bats rarely fly in rain as the rain interferes with their echo location, and they are unable to locate their food (Kunz, 1982).

The social structure of bats varies, with some bats leading a solitary life and others living in caves colonized by more than a million bats (Tuttle and Moreno, 2005). According to Kunz (1982) the fission-fusion social structure is seen among several species of bats. The term "fusion" refers to a large numbers of bats that congregate together in one roosting area and "fission" refers to breaking up and the mixing of subgroups, with individual bats switching roosts with others and often ending up in different trees and with different roost mates.

2.2 The Role of bats in the Ecosystem

Bats are an essential natural resource that play great role in providing many ecological and economic services (Fujita and Tuttle, 1991). They have long been postulated to play important ecological roles in prey and predator, arthropod suppression, seed dispersal, pollination, material and nutrient distribution, and recycle (Kunz *et al*., 2011).

2.2.1 Bats as predators

Bats have diverse patterns of feeding in which some select among available prey while others are generalist predators, feeding on a wide diversity of taxonomic groups. They also opportunistically consume appropriately sized prey depending on availability within a preferred habitat (Anthony and Kunz, 1977). Their prey size can vary from 1 mm (midges and mosquitoes) to as large as 50 mm long (beetles and large moths) based on the species of bat (Anthony and Kunz, 1977).

Remains of 12 orders or classes of prey belonging to 18 taxonomic families of insects were reported in the diet of bats (Speakman, 1991). The prey items include Acari, Arachnida, Coleoptera, Diptera, Hemiptera, Homoptera, Hymenoptera, Isoptera, Lepidoptera, Neuroptera, Orthoptera, and Trichoptera. They also predate on frogs, fish, small mammals, and even blood of mammals and birds (Kunz *et al*., 2011). Some species also eat unusual prey items such as scorpions and spiders (Speakman, 1991).

2.2.2 Bats as prey for vertebrates

Although there are relatively few observations of animals feeding on bats, a number of vertebrate predators like fish, amphibians, birds, reptiles, and mammals prey on bats throughout the world (Speakman, 1991). The main bat predators are owls, hawks, falcons, snakes, and mammals such as raccoons, ringtails, and opossums. In some countries like New Zealand, forest-floor dweller bats are frequently predated by the introduced rats, feral cats, and weasel (Daniel and Williams, 1984). The larger phyllostomid bats (*Vampyrum spectrum*, *Chrotopterus auritus*, and *Phyllostomus hastatus*) are known to eat smaller bats (Daniel and Williams, 1984)

2.2.3 Hosts for parasite

Numerous haematophagous ectoparasites such as bat fleas (Ischnopsyllidae), bat flies (Nycteribiidae), bat mites (Spinturnicidae), and bugs (Cimicidae) live on the skin surface and in the fur of bats. These obligate ectoparasites are specialized to their hosts (Messenger, *et. al*., 2005). The skin and hair morphology play important roles in affecting the parasite's life style in terms of adaptation, feeding, movement and egg laying resulted in morphological adaptations with co-evolution of both species (Messenger *et. al*., 2005).

2.2.4 Pollination and seed dispersal agents

Bat pollination occurs in more than 528 species of 67 families and 28 orders of angiosperms worldwide (Fleming *et al*., 2009). Pteropodid bats are known to pollinate flowers of about 168 species of 100 genera and 41 families and phyllostomid bats pollinate flowers of about 360 species of 159 genera and 44 families (Fleming *et al*., 2009). As feeding on nectar and pollen requires relatively specialized morphology (e.g.,

elongated snout and tongue), relatively few members of these families are obligate pollinators.

Seed dispersal is a major way in which animals contribute for ecosystem succession by depositing seeds from one area to another (Duncan and Chapman, 1999). As 50–90% of tropical trees and shrubs produce fleshy fruits adapted for consumption by vertebrates, the role played by frugivorous bats in dispersing these seeds is tremendous (Howe and Smallwood, 1982). Countless tropical trees and understory shrubs are adapted for seed dispersal by animals, primarily by bats and birds. Fruit-eating bats are uniquely suited for dispersing the seeds of "pioneer plants" from which a diverse and healthy forest can re-emerge (Duncan and Chapman, 1999).

2.2.5 Soil fertility and nutrient distribution

For soil fertility and nutrient distribution, bat guano has a great ecological potential as bats sprinkle it over the landscape throughout the night. Thus, bats contribute a lot in nutrient redistribution, from nutrient-rich sources (e.g., lakes and rivers) to nutrient-poor regions such as arid or upland landscapes (Howe and Smallwood, 1982). For instance, a colony of one million Brazilian free-tailed bats (*Tadarida brasiliensis*) in Texas can contribute to 22 kg of nitrogen in the form of guano. Bat guano in turn supports a great diversity of organisms including arthropods, fungi, bacteria, and lichens that represent different trophic levels (Duncan and Chapman, 1999).

2.2.6 Bats as bio-indicators

Bats are excellent ecological indicators of habitat quality. They have enormous potential as bio-indicators to both disturbance and the existence of contaminants due to a combination of their size, mobility, longevity, taxonomic stability, observable short and long term effects, trends of populations, and their distribution around the globe (Fenton *et al*., 1992; Fenton, 2003; Jones *et al*., 2009;). High fatalities observed in bats associated with diseases, may provide an early warning of environmental links among contamination, disease prevalence, and mortality. Increased environmental stress can suppress the immune systems of bats and other animals and thus one might predict that the increased prevalence of diseases is a consequence of altered environments (Fenton, 2003).

2.3 The Economic Importance of Bats to Man

2.3.1 Biological pest control

Among the estimated 1,232 extant bat species, over two-thirds are either obligate or facultative insectivorous mammals. They consume nocturnal and crepuscular species of insects from different habitats such as forests, grasslands, agricultural landscapes, aquatic, and wetland habitats (Kunz, 2003). Various species of prominent insect pests have been found in the diet of bats based on identification of insect fragments in faecal samples and stomach contents. They consume enormous quantities of insects. Bats are one of several groups of animals that prey upon mosquitoes. A Florida colony of 30,000 southeastern myotis (*Myotis austroriparius*) eats 50 tons of insects annually, including more than 15 tons of mosquitoes (Anthony and Kunz, 1977). It is also known that

northern long-eared bats (*Myotis septentrionalis*) suppress mosquito populations through direct predation (Reiskind and Wund, 2009).

2.3.2 Guano mining

Guano from bats has long been mined from caves for use as fertilizer on agricultural crops due to its high concentrations of limiting nutrients like nitrogen and phosphorous (Hutchinson, 1950). It provides some of the world's finest natural fertilizers (Tuttle and Moreno, 2005). About 950 bat guano products show a market demand for the product. Prices for bat guano organic fertilizer varied from $1.25 to $12.00 per 0.5 kg depending on the size of the package (larger packages have lower unit prices) and the mix of its ingredients (Kunz *et al.*, 2011). Bat guano is still considered a valuable fertilizer resource in some parts of the world such as Thailand and Mexico.

2.3.3 Bush meat and medicine

Bats have also long been used for food and medicine (Eiting and Gunnell, 2009). They provide a direct source of human food in many countries (Mickleburgh *et al*., 2009). Several studies have reported on the overhunting of bats for bush meat indicating a need for further conservation (Abulude, 2007). Though, the recent outbreak of Ebola disease in West Africa has greatly install fear in people who hunt bats for bush meat.

Physicians used bats to treat ailments of patients ranging from baldness to paralysis (Schleuning, 2000; Mickleburgh *et al*., 2009). The anticoagulant compound called salivary plasminogen activator found in the saliva of the common vampire bat is used to

treat strokes. Unlike alternative medicines, it can be administered even much later after a stroke has occurred and still be effective (Schleuning, 2000).

2.3.4 Aesthetic and bat watching tourism

Although perhaps not as widely practiced as bird watching, bat watching is currently growing as a recreational activity (Tapper, 2006 and Hudt, 2012). Similar to other wildlife watching tourism, it also generates income in the form of entrance and permit fees, personal payments to the guides, drivers and scouts and payment for accommodation, and other services (Tapper, 2006). The majority of bat watching takes place at cave entrances where bats emergence can be viewed. For this purpose, the charge ranges from $5 to $12 per visitor. For instance, according to Tapper (2006) the Congress Avenue Bridge, which is the home to the largest urban bat colony of approximately 1.5 million Mexican free-tailed bats (*T. brasiliensis*) in USA is visited by 200–1,500 visitors per evening with the value of $3 million per year. The spectacular flock emergence of bats from their roost from March to November, to feed and migrate south during the winter months serves as tourist attraction (Tapper, 2006).

2.3.5 Bats as pests

Although bats are grouped among the world's gentlest animals that provide many positive ecological and economic benefits, few of them are considered as pests (Kelly, 2012). They may cause damage to human, livestock, agricultural crops, airplane strike, building, and infrastructure infestation, and rarely become aggressive or bite humans

during self-defence (Tuttle and Moreno, 2005). For instance, frugivorous bats that feed on some economically important fruits result in greater loss (Jones, 2009).

2.3.6 Disease transition and contamination

Bats differ from other disease reservoirs because of their unique and diverse lifestyles, including their ability to fly, often highly gregarious social structures, long life spans, and low fecundity rates (Calisher *et al*., 2006). In spite of their ecological values, bats are known in different parts of the world as hosts to a range of zoonotic and potentially zoonotic pathogens, including the rabies virus (Messenger *et al*., 2005, Schneider *et al*., 2009) and the fungus *Histoplasma capsulatum*, which can develop on bat faeces under particular conditions (Lewis, 1989; Gugnani and Muotoe – Okafor, 1997; Taylor *et al*., 1999). Additionally, there is evidence that bats may serve as reservoirs of other viruses such as, or closely related to, Severe Acute Respiratory Syndrome coronavirus (SARS), Hendra, Nipah, Marburg, Ebola, and Tioman (Breed *et al*., 2006, Calisher *et al*., 2006, Wong *et al*., 2007, Yaiw *et al*., 2007).

2.4 Daily and Nightly Activity of Bats

Bats typically seek shelter in roosts during the daytime and are active on the wing at night departing their roosts shortly after sunset and returning before sunrise. The timing of nightly departure and return is closely synchronized with light levels and is associated with seasonal changes in day length (Koopman, 1993). One or more feeding periods may occur on a given night, depending on food availability and the temperature of the night air. Kunz and Reynolds (2003) reported that bats feeding activity is often interrupted by

periods of night roosting, where individuals seek temporary shelter alone or in small groups in open buildings, on the rafters of porches, carports, and breezeways. Moonlight may influence the nightly activity of some species (Thomas, 2011).

2.5 Bat Roosts and Roosting Behaviour

Roost is a place where bats settle or congregate to rest in the day or night (Vanlalnghaka, 2013). Bats have been discovered to use roosting niches that are indoors (human dwellings, outbuildings, livestock quarters, warehouses), semi-enclosed (loading docks, entrance foyers), partially sheltered (porches, carports, pavilions, highway underpasses, bridges), open structural areas (window shutters, signs), and in trees (Frantz, 1988). Unusual roosting areas include wells, sewers, and graveyard crypts. Bats use roosts for different reasons based on the time of day and the time of year (BCT, 2007). Roost types include the maternity roost, hibernation roost, day roost, and night roost.

2.5.1 Maternity roosts

When the weather gets warmer, usually in early hot season, pregnant female bats gather together in warm, safe places to have their babies (Thomas, 2011). These roosts are called maternity roosts. Some groups of bats return to the same site every year. Bats are very sensitive during the maternity season and may abandon their young if they are disturbed. Warm and dry indoor spaces like roof space are often ideal for maternity colonies (Hudt, 2012).

2.5.2 Hibernation roosts

In winter, some bats go into hibernation (Thomas, 2011). Hibernation is an extended period of deep sleep (or torpor) that allows animals to survive cold winters with harsh weather. A bat's body temperature lowers and their metabolic rate slows, meaning they use less energy and can survive on the fat they have stored up instead of trying to forage for food (Thomas, 2011). During hibernation, bats need roosts that are cool and remain at a constant temperature. Being aroused by disturbance while hibernating, costs the bats a lot of energy, which makes them lose body fat and can lead to starvation (Kunz, 1982).

2.5.3 Day and night roosts

During the day, bats typically want protected roosts that are free of disturbances and predators, and which provide dark, quiet conditions where they can rest for several hours (Basham *et al.*, 2011). Day roosts are usually above ground, and can be as many as 30 miles away from foraging grounds and water sources. At night, however, bats feed and roost intermittently so they choose roosts that are in convenient proximity to their foraging grounds (Basham *et al.*, 2011). Trees, porches, and even abandoned bird nests are common examples of the temporary roosts used by bats while feeding at night (BCT, 2007). Where bats forage may change as weather conditions and insect populations change; hence, these fleeting nighttime roosts are easily abandoned for more convenient ones (Anthony and Kunz, 1977).

2.6 Bat Roost in Buildings and Preference

Bats roost in buildings because their natural roosts (tree holes, tree bark and caves) have become more scarce or disturbed as a result of human activities (Hudt, 2012). Some bat species will make use of buildings on occasion, but for some species, buildings are essential as roost sites. Bats have been reported to be found in a variety of buildings BCT, 2007). All buildings in particular the walls, wall cavities and crevices, attics, cellars, eaves, soffits, and roof coverings are potential roost sites. In addition some species may require space to fly within the building before departing to feed each evening (Hudt, 2012).

Bats spend half of their life in the roosts therefore the selection of the roosting site is crucial (Kunz, 1982). It is often influenced by the microclimate, surrounding vegetation, human interference, structural characteristics of the roost, risk of predation and the availability of food throughout the year (Kunz, 1982). Some types of buildings appear preferable (older houses, churches, barns, proximity to water) as do certain roost locations therein, especially areas with little disturbance, low illumination, little air circulation, and high temperatures (Hudt, 2012).

2.6.1 Locating bat roost in buildings

It is not always possible or convenient to conduct a bat watch, thus, a detailed inspection inside the building for bats or bat sign may be necessary to find specific roosts (BCT, 2007). Daytime is best, especially during the warmer part of the day (Hudt, 2012). Bats roost in the most varied kinds of buildings and in every part from cellar to attic. Often it is easy to locate bats, especially in warm weather in attics or lofts, where they may hang in clusters or side-by-side from the sloping roof lath, beams, and so forth. However, bats

have the ability to find crevices and cavities, and if disturbed may rapidly disappear into the angles between converging beams, behind such beams or wallboards, into mortise holes on the underside of beams, and into the multilayered wall and roof fabrications. If bats cannot be openly observed, usually there are various interior and exterior signs of their presence (Hudt, 2012). The presence of bats in a building is usually evidenced by noise and by the presence and distinctive pungent odour of the accumulated faecal droppings and urine (Hudt, 2012).

2.6.2 Impact of bats on building and potential nuisance

On occasion bats roosting in a building can cause a nuisance and some form of intervention may be needed while in some cases no intervention may be needed (BCT, 2007). Unlike rats bats do not gnaw or chew on wood, metal, or plastic to gain entry or exit to and from buildings they merely take advantage of existing gaps or holes nor do they build nests as do birds (Schneider, 2011). Holes on roof or walls are not damage caused by bats (BCI, 2000). Koski (2014) indicated that the types of damage bats can do to a building are basically three; Spread of disease, introduction of mites and structural damage. Gore and Studenroth (2005) reported that bats roosting in buildings pose little threat to humans, as long as the bats are not directly contacted.

Bats, like other wild mammals carry rabies, but rarely bite humans unless during self defense. Along with the risk of rabies, bat guano carries the spores for histoplasmosis, a disease mainly affecting lungs of people, especially those with immunity disorders, the elderly and the very young children.

2.7 Global and Legal Status of Bats

There are over 1000 species of bats, accounting for 20% of all mammal species globally. Of these 1000 species, almost a quarter are globally threatened (Mickleburgh *et al*., 2002). In many cases bats account for a substantial proportion of a country's mammalian biodiversity, indeed in some oceanic islands, they are the only indigenous mammals and play a vital role as keystone species in ecosystems (Cox *et al*., 1992; and Mickleburgh *et al*., 2002). The major global threats to bats are: habitat loss or modification; roost site loss or disturbance; health issues; persecution; lack of information; and over exploitation for food (Mickleburgh *et al*., 2002).

Pressure on vital resources due to increasing human populations that lead to the loss or modification of foraging habitats and roosts is arguably the greatest threat to bat species (Serpell, 2004). In addition there is a negative public image about bats that influences people's responses to issues such as human health risk and conflict between fruit consuming bat species and fruit growers (Sexton and Stewart, 2007). This negative public image that bats frequently have, and the resulting persecution, can potentially be partly attributed to people being ignorant to the life history of bats and their role in the ecosystem (Mickleburgh *et al*., 2002). Jones (2009) and Mickleburgh *et al*. (2002) highlighted the lack of attention that bat species receive from the local conservation community as a crucial concern. According to Schneider (2011) some countries have laws that specifically mention bats, either providing or denying protection. Others have legislation that applies to bats only by interpretation, since bats may be considered nongame wildlife mammals (Schneider, 2011). Some bats have protection as either

federal or state-listed endangered species, but the same state may not protect other species of bats (Mitchell-Jones and McLeish, 2004; Hudt, 2012).

According to Hudt (2012) countries with bat laws enforcement and public education must accompany legislation to accomplish the intended goal of protecting the public and saving endangered bats. Familiarity with the appropriate federal and state laws should precede any nuisance management activities. Schneider (2011) and BCT (2012) asserted that, today, in many developed countries, the lethal control of bats, even when there is a proven potential danger to humans, often is subjected to careful scrutiny and interagency coordination.

2.8 Efforts towards Bats Conservation

Through the efforts of conservation agencies, such as the Organization for Bat Conservation (OBC), Bat Conservation International (BCI), Bat Conservation Trust (BCT), African Bat Conservation (ABC) and International Union for the Conservation of Nature (IUCN) among others bats are becoming better understood and people are beginning to understand the crucial role bats play in insect control and pollination (Morton and Murphy, 1995).

2.9 Human Attitudes, Wildlife and Environmental Knowledge

An attitude can be generally defined as the tendency to think, feel, or act positively or negatively toward objects in our environment (Eagly and Chaiken, 1993). Psychologists define attitude as a learned tendency used to evaluate things in a specific way. Such

evaluations are often positive or negative but they can be uncertain due to mixed feelings regarding a particular situation. Psychologists consider attitudes as having three components: the cognitive, the affective, and the behavioural (Oppenheim, 1992).

Knowledge regarding wildlife is one of the predictors of attitudes towards them for both adults (Tarrant *et al*., 1997) and children (Guitterrez-de-White and Jacobson, 1994). This relationship is also not unique to animals, but also overall environmental knowledge and attitudes (Arcury, 1990). However, the relationship between attitude and knowledge is a complex and is still not fully understood (Zimmerman, 1996). For example, Steel (1996) found that those individuals that scored higher on an environmental attitudes questionnaire were more likely to participate in pro-environmental behaviours. Knowledge regarding manatees (*Trichechus* spp.*)* was positively correlated with conservation support for the species (Aipanjiguly *et al*., 2003). Bradley *et al*. (1999) found that after an environmental science course, students had higher environmental knowledge and attitudes between the pre- and post-tests. In both the pre- and post-tests, students with higher knowledge scores also had higher attitude scores when compared with students who had lower environmental knowledge scores.

In contrast, there are several works that failed to find clearly significant relationship between attitude and knowledge. For instance, Kuhlemeier *et al*. (1999) and Makki *et al.* (2003) found only moderate correlation between environmental attitude and knowledge. Therefore, the link between attitude and knowledge is not definitely resolved yet and, in agreement with earlier view of Kellert and Westervelt (1984), the level of knowledge can be considered as one of several factors affecting attitudes.

2.9.1 Importance of human attitudes to conservation biologists

Numerous examples exist at the level of society where changes in people's attitudes and opinions have altered public-policy and legislation, whether this is for environmental issues or otherwise (Serpell, 2004). It is essential for conservationists to understand public attitudes and values towards wildlife as it influence policy decisions (Majic and Bath, 2010). With human population increasing throughout the globe, wildlife is increasingly dependent on dispersal areas now occupied by humans (Kunz and Reynolds, 2003). Consequently, enlisting the support of local people and students is and will continue to be critical to the management and conservation of species (Browne-Nunez and Jonker, 2008). Typically, attitudinal surveys are used as a baseline with which to test management and policy decisions, providing wildlife officials and stakeholders with the data needed to discuss competing public beliefs, address potential misunderstandings, and develop solutions (Browne-Nunez and Jonker, 2008). Beyond baseline information, many researchers are now calling for attitudinal and belief monitoring to inform management decisions (Manfredo, 1998; Mccomas and Scherer, 1999; Kaczensky, *et al*,. 2001; Majic and Bath, 2010).

2.9.2 Attitude dimensions

Numerous researchers have sought ways to represent human attitudes towards wildlife and the environment (Barner, 2013). Of all the research carried out in this area, perhaps the best known and most widely cited is that of Kellert's attitude typologies (Kellert, 1996) who delineated a typology of values to wildlife:

Aesthetic: Primary interest in the physical attractiveness and symbolic appeal of animals, **Dominionistic:** Primary interest in the mastery and control of animals, **Ecoscientistic:** Primary concern for interrelationships among species, as well as between species and natural habitats. Interest in the physical attributes, taxonomic classification and biological functioning of species, **Humanistic:** Primary orientation of strong emotional affection for individual animals, principally pets, **Moralistic:** Primary concern for the right and wrong treatment of animals, with strong opposition to presumed cruelty toward animals, **Negativistic:** Primary orientation - a fear, dislike, or indifference toward animals and their conservation, **Naturalistic:** Primary interest in direct outdoor recreational contact and enjoyment of wildlife, and **Utilitarian:** Primary interest in the practical value of animals or the subordination of animals for the material benefit of humans.

Kellert's attitude typologies have served as the conceptual framework for numerous studies due to them being mutually exclusive and collectively exhaustive of attitudes to wild animals (Browne-Nunez and Jonker, 2008). For example, Prokop *et al*. (2009) investigated atttitudes towards bats in Slovakia, specifically looking at respondents attitudes based on scientistic, ecologistic (now combined into one dimension: ecoscientistic) and negativistic attitude dimensions. The author found significant differences between respondents expression of these attitude dimensions. Sheeline (1991) found that negativistic attitudes were exhibited by respondents in relation to bats, especially so by younger generations, expressing the analogy of bats to rats. Respondents claimed that bats had a strong smell and an undesirable appearance when dead (lips curled back, tongue extruding).

There was also a general consensus that fruit bats are dirty and transmit disease. Cousins and Compton (2005) found respondents questioned on Mangia in the Cook Islands believed fruit bats to be dangerous and 'when alive they may bite your hand'. Other respondents did not consider bats to be a threat but simply did not like them, describing them as 'nasty little rat-like creatures'. This fear, dread and dislike of "digusting animals" are widely researched and a key factor in hostility towards animals such as spiders, snakes and bats (Prokop *et al*., 2009). The 'disease avoidance' hypothesis, comprised of three subcategories, attempts to explain this phenomenon and a summary is provided by Prokop *et al*. (2009).

2.9.3 Attitudes and behaviour

As previously pointed out, it is essential to understand people's attitudes and values for the role they play defining policy and management decisions. Additional to this it is apparent that attitudes and beliefs must be understood, as they are posited to influence human behaviour (Ajzen and Fishbein, 1980; Browne-Nunez and Jonker, 2008), and therefore understanding individuals attitudes can help conservationists better predict human behaviour (Browne-Nunez and Jonker, 2008). Despite this, the links between attitudes and behaviour are far from simple and conservation biologists have been critisised for making incorrect assumptions about behaviour management decisions (Barner, 2013). Often there is a mismatch between their assumptions and actual behaviour (Dickman, 2010). The ability of attitudes to predict behavioural intentions and actual behaviour will continue to be a major focus of theory and research (Ajzen, 2001).

Understanding the causal links and predictors between attitudes and actual behaviours in each given context is essential for making decent management decisions.

2.9.4 Underlying socio-demographic factors

It is clear then that people do not base their perceptions and attitudes solely upon facts and no amount of scientific evidence will ever be sufficient to bring about improvements in the conservation of a species if the species or conservation intervention does not resonate with public attitudes and values (Barner, 2013). Hence providing mitigation alone to a wildlife damage issue will not mean negative attitudes and behaviour reduce concomitantly and to a proportionate degree (Dickman, 2010). In reality, peoples' attitudes and resulting behaviour are results of not just personal experiences but also a wide variety of social factors that are rarely considered to the required level. These socio-demographic factors (Kellert 1985; Kellert, 1996; Bjerke and Vitters 2000; Ericsson and Heberlein 2003; Kleiven *et al*., 2004; Majic and Bath 2010) include gender, age, religion, knowledge, place of residence among others.

2.9.4.1 *Gender*

Substantial evidence now exists to say that women tend to show stronger affective and weaker utility orientation than men, a review of which is provided by Serpell (2004). One example is Bjerke (1998) who found significant differences between males and females based on Kellert's attitude typologies, with males expressing higher dominionistic and ecoscientistic scores than females who scored higher on humanistic and negativistic

scales. Similarly, and expressing a dominionistic attitude, Mulder (2009) found that boys were almost twice as tolerant as girls with regard to hunting wild animals.

2.9.4.2 *Age*

Age has also been found to influence attitude in a similar way to male and female differences, although this has been postulated as a cohort effect as opposed to a maturational one (Kellert and Berry, 1987) due to life-long attitudes and behaviour decisions toward animals being based on childhood experiences (Mulder, 2009). This is supported by Bjerke (1998) who found that attitudes formed early in life tend to be persistent.

2.9.4.3 Religion

Religion has also been found to have significant effects on attitude. Serpell's (2004) review of the literature found out that both religiosity and frequency of attendance to religious services are linked to attitude, leading to a stronger emphasis on utility and less on positive affective responses. It is noted however that these findings only consider western Judaeo-Christian religions (Barner, 2013).

2.9.4.4 *Knowledge*

Knowledge influences the three underpinning predictors of behaviour: attitude, subjective norms and perceived behavioural controls (Ajzen, 1991). In addition, it has been widely proposed that knowledge is an essential precursor to attitude formation and beliefs relate directly to the knowledge a person has about a specific issue or question (Kellert and Westervelt, 1984; Kaiser, 1999). Similarly, research on environmental topics has found

that the higher a person's actual knowledge the better their attitude (Cohen, 1973; Mangas and Martinez, 1997; Bradley *et al*., 1999; Aipanjiguly *et al*., 2003 and Prokop *et al*., 2009).

Contrastingly other studies have found that environmental education increases knowledge about a topic but this does not always translate into a better attitude of the topic (Kuhlemeier *et al*., 1999; Makki *et al*., 2003; Lukas and Ross, 2005; Brossard *et al*., 2005). These contrasting studies clearly show that whilst knowledge is not exclusive in determining attitude it is often a contributing factor. An important distinct between knowledge and information should also be noted in that whilst it is possible to provide information to people this does not always result in an increase in their knowledge of the topic. This raises questions as to the source of peoples information, be it from television news reports, newspapers, radio broadcasts or otherwise. Such sources may sensitize people to a particular topic and increase their awareness of it but this does not necessarily mean that it increases their knowledge of the topic (Gomez-Granell and Cervera-March, 1993).

2.10 Cultural Myths and Beliefs

Bats rank among the most misunderstood and intensely persecuted mammals because they are active only at night and difficult to observe and understand. Acceptance of culturally significant myths and beliefs can have profound effects both positively and negatively (Prokop *et al*., 2009). Bats feature heavily in folklore of many cultures, especially in African communities. The influence folklore has on attitudes to bats cannot be underestimated and beliefs surrounding them often persist in continuity regardless of

the contemporary situation. News media, movies, television, story books and cultures often perpetuate myths, folklore, legends, and fears about bats that a surprising number of people believe and have developed negative attitudes towards them (Thomas, 2011). Fruit bats are frequently perceived as a pest however Sinavaiana and Enright (1992) reported that bats being perceived as a pest species is in some cases not a contemporary issue at all, describing how hunters used to catch bats whilst they fed upon flowing banana plants in plantations in the 30's. Nevertheless, aside from the damage a species may do, perceptions of that species as innately evil or harmful mean that even if damage is mitigated or compensated the residual fear and antagonism mean persecution of that species is likely to remain (Dickman, 2010).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

The study area is Zaria (Figure 3.1) which is located between latitude 11°15'N and 11°3'N of the equator and longitude 7°30'E and 7°45'E of the Greenwich meridian (Idowu, 2010), in Kaduna State, Nigeria. The dry season in Zaria lasts for a period of six months (November to April), and the rainy season is from May to October (Hore, 1970). The annual rainfall ranges between 1,000 mm to 1,114 mm (Happold, 1987), with a mean daily temperature of 27°C. The relative humidity ranges from 70 - 80% in August to about 15-20% in December (Yusuf and Associates, 1981). The natural vegetation is typically that of the Northern Guinea Savanna and is composed of shrubs, herbs, grasses and sparsely spaced trees (Hore, 1970). The dominant trees within the area include *Mangifera indica*, *Gmelina* sp., *Delonix regia*, *Azadirachta indica*, *Eucalyptus citriodor*, *Albezi lebec*, *Khaya senegalensis*, *Spathodea campanulata*, *Pisidium guajava* and *Carica papaya* (Adang, 2007). Zaria is bounded to the north by Funtua Local Government of Katsina State, to the West by Birnin Gwari Local Government Area, to the East and South-East by Ikara and Lere Local Government areas of Kaduna State, respectively (Adang, 2007). The area transverses about 70Km from the West to East and roughly covers 8,950 square kilometer. The area includes; Kubanni Dam, River Galma, Zaria city, Tudun Wada, Gyallesu, Nagoyi, Wusasa, Gwargwaje (Idowu, 2012). The population of Zaria was projected to be 472,860 in 2011, the density of population ranges from 50-200 persons per square kilometer (NPC, 2006).

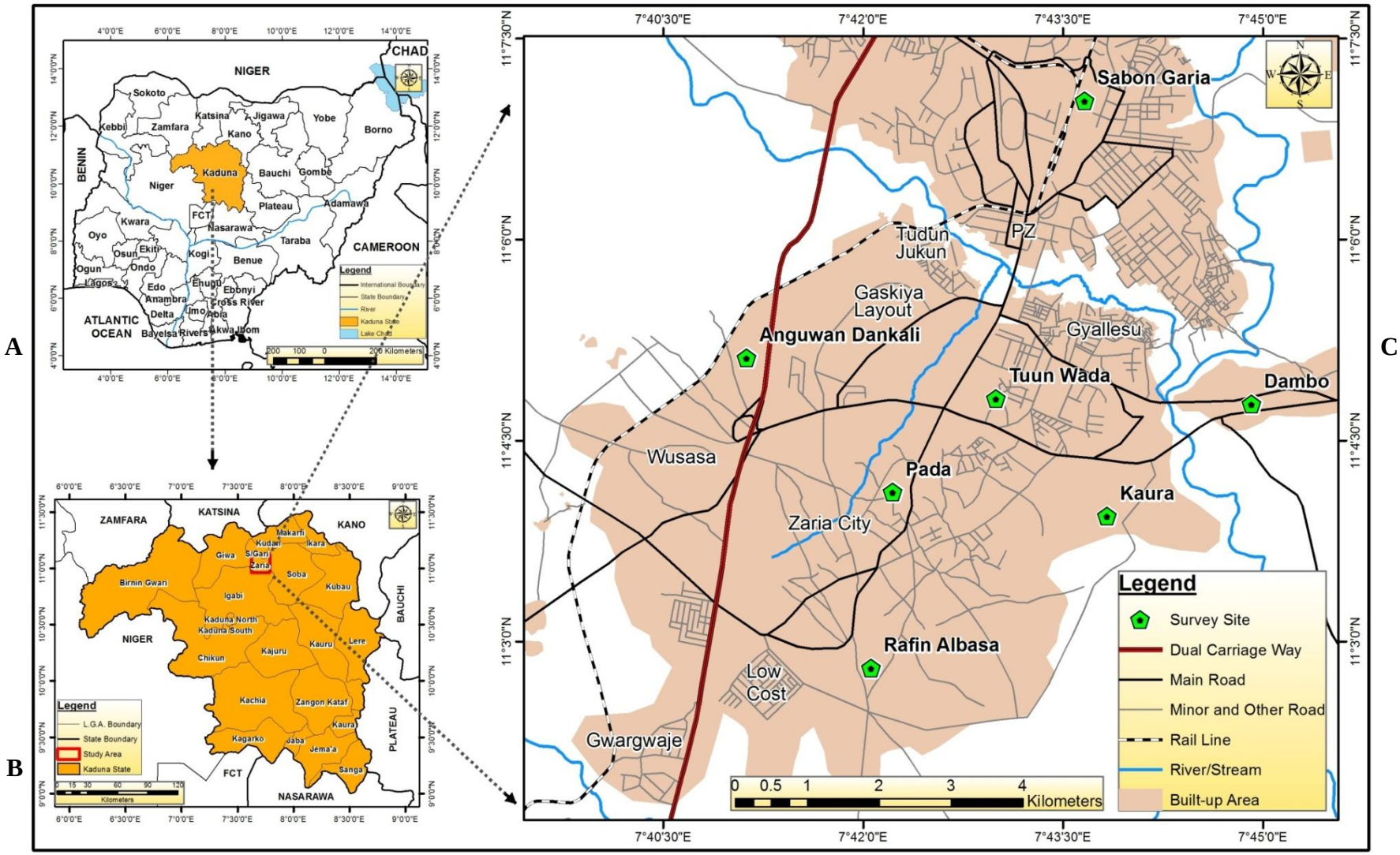


Figure 3.1: Map of Nigeria (A), Kaduna State (B), Zaria Local Government Area (Survey sites) (C)

Source: Modified from the Administrative Map of Zaria

3.2 Experimental Design

Bat roosts were identified through internal and external inspection survey of all the 75 public primary and secondary school buildings located within Zaria metropolis. Those with evidence of bat roosts were then selected for emergence and re-entry observations to determine the colony size. The characteristics of occupied buildings were noted in comparison with unoccupied ones, the nuisance and nature of damages associated with roosting bats in schools were also documented. Demographic data were generated using Questionnaires to assess the overall attitudes and knowledge of students about bats. Thereafter, educational unit was designed (Appendix VII) and presented to selected group to determine the effectiveness of education in improving/changing student's wildlife perceptions. Results of the findings were presented using text, tables, figures and plates.

3.3 Ethical Clearance

Prior to the commencement of the study, an introductory letter was obtained from the Department of Biological Sciences, Faculty of Science, A.B.U. Zaria to seek ethical permission from both Zaria Local Government Education Authority and Kaduna State Ministry of Education, Zaria Inspectorate Division, to conduct the study. The Headmaster/Principal and teachers of the schools visited were briefed on the purpose of the research.

3.4 Study Populations

The population of this study consisted of all the 139 public primary and secondary schools within Zaria metropolis under Zaria Local Government Education Authority

and Kaduna State Ministry of Education Zaria Inspectorate division. There were 51 and 24 public primary and secondary schools respectively.

The population of primary and secondary school students in the study area was 78,023 consisting of males and females, all of which were targeted for this study.

3.5 Sampling and Sampling Techniques

All the public primary and secondary schools in Zaria metropolis were surveyed for bat roost evidence. Those with bat roost evidence were then selected for further emergence and re-entry observations three times at the interval of one week each during raining season. Random sampling was used to compare the characteristic feature of schools with and those without roosting bats for roosts preference.

For questionnaire administration, Krejcie and Morgan (1970) table for determining sample size (Appendix IV) was used. The sample size was 384. Simple and systematic random sampling techniques were employed in the selection of schools and students respectively. Six public schools (i.e. two primary schools, two junior and senior secondary schools) within Zaria metropolis were randomly selected using the balloting. Class attendance register was obtained in each selected school and systematic random sampling technique was employed in the selection of students whose names appeared on the register with even numbers. In each school, this procedure was adopted until 384 students were duly selected across the primary, junior and senior secondary schools and allotted equal number of questionnaire. Class attendance register was used to ease the tracing of student's previous questionnaires (pre-test) of those were presented with the educational unit for pre-test and post-test comparison.

3.6 Timing of the Roosts Surveys

To optimize the likelihood of recording bats evidence, the survey was conducted when the school children were on holiday which also coincided with the period that bats were most active (August – November) and their resource requirements (such fruits, insects) were abundant (Ford *et al*., 2005; Threlfall *et al.*, 2011).

3.7 Locating Bat Roosts

Bat roosts were identified by internal and external inspection of all public schools in the study area according to BCT (2007). One copy of a questionnaire was hand delivered to every school during the survey to find out whether the school management was aware of bats roosting in their school.

3.8 Inspection of Public Primary and Secondary Schools

Public primary and secondary schools were inspected internally and externally during daylight hours, using strong torch lights, binoculars and ladder when required, to search for evidence of roosting bats such as live bats, remains of dead bats, droppings (guano), food remains, characteristic odour, urine staining, roost access points, area cleared of cobwebs, polished/oily stains around possible entrances (holes/cracks), particular attention to areas suitable to support roosting bats including joints, crevices and gaps between roofing materials (BCT, 2007). A school was recorded as occupied provided one or more of the above mentioned signs were observed as they indicate regular use by bats (Jeffery and Karl, 2005).

The visited schools were also examined to establish other possible roosting sites around the school environment such as on trees and other abandoned built structures

(Hudt, 2012). Each visit to a school took approximately 30 minutes from the time of arrival to time of departure. The time spent in each school was enough for the observations, and also to get all the necessary information needed (Hudt, 2012). Photographs were taken at each confirmed sites to document the observed nuisance or damage associated with roosting bats

3.9 Dusk Emergence and Dawn Re-entering Observations

Dusk emergence and pre-dawn re-entering observations were conducted in schools with evidence or sign of bats based on guide produced by Hudt (2012) and Noromampiandra *et al*. (2010). These were conducted to observe the time when bats were leaving or returning to roost, whether solitary or in colony, number of bats present and entrance points.

Emergence observations commenced 30 minutes before the sunset until one and the half minutes after sunset (Hudt, 2012), and were conducted three times in each established roost as recommended by BCT (2007). The emergence counts were done using hand held counter (Noromampiandra *et al*., 2010) and camera (BCT, 2007). Bats emergence time for each watch was recorded; the number of emerging bats were counted and the exits holes were photographed using digital camera for evidence. No record was taken for re-entry observations as most of the watch was unsuccessful. Field Assistants were employed in most cases due to the complexity of some schools.

3.10 Schools Assessment for Bats Roost Preference

To determine the characteristic features that bats select for roosts in schools, 25% (Gore and Studenroth, 2005) of schools were randomly sampled from each educational district. They are then revisited concurrently with schools that had

evidence of bat roost for comparison. The following variables were assessed based on Robin (2012) categorization for bat roost preference include; usage status; whether the school has abandoned structure or in-use. Illumination was given four levels based on estimated proximity of light around the roost: low, medium, high or none. Low illumination had only distant lamps to shine by the roosts. Medium had a few but very close street lamps. High illumination had lights on the building that brightly lit at night.

Distance to water body was put into two categories; schools located ≤ 2km away from water body, and those located more than 2km away from water source. Age of the building was grouped into two; schools established less than 10 years to date and those established more than 10 years ago.

The surrounding vegetation was placed in the categories of completely covered, half covered, scattered, or none. "Completely covered" referred to buildings that were almost completely obscured by trees. "Half covered" buildings has one or two trees and some bushes around the roost entrance. Scattered vegetation lacked nearby trees and there were few. Buildings with no vegetation had no trees or bushes. Roost surroundings were classified as either open or enclosed. Open roosts had a greater height than their surroundings while enclosed roosts were next to other buildings or were obscured in some way.

3.11 Measuring Students Attitudes, Knowledge and Perceptions about Bats

A structured questionnaire (Table 3.2; Appendix V) was used to address objectives iii and iv. The questionnaire used closed questions and comprised of multiple choice selections where respondents were asked to tick their selected answer. The

questionnaire was adapted from Barner (2013) and modified to suit the present study. Students attitudes towards bats were assessed using the various attitudinal dimensions by Kellert (1996) (Table 3.1).

3.11.1 Administration of questionnaire

Equal questionnaires (64) were allotted to each of the selected schools and were self administered with the help of the Biology teacher or any available science teacher of the selected schools. The items in the questionnaire were read out to primary pupils and in most cases translated into local language to facilitate understanding of each statement before ticking their desire option, while the junior and senior secondary students were given to fill it on their own.

3.12 Measuring Attitude Change as a Result of Knowledge Gained

After accessing all the recommended textbooks by Science Teacher Association of Nigeria (STAN); Modern Biology, New Biology for West African Schools, Fundamentals of Biology for Senior Secondary Schools, and STAN Basic Science and Technology (for primary and Junior secondary schools) (Udeani, 2013) used in schools in the study area to ascertain the extent to which bats are appreciated in different regards, an educational unit on the biology of bats and their conservation was designed (Appendix VII). The educational unit was aimed at (i) promoting student's awareness and understanding of bats biology and their ecological roles (ii) dispelling misconceptions/myths about bats lifestyle and conservation issues were emphasized.

Table 3.1: Attitude Dimensions of Kellert (1996) adapted for bats

ATTITUDE DIMENSIONS	DESCRIPTIONS
Aesthetic:	Interest in the physical attractiveness and symbolic appeal of bats.
Dominionistic:	Interest in the mastery and control of bats.
Ecoscientistic:	Primary concern for interrelationships among bats and other species, as well as between bats and natural habitats. Interest in the physical attributes, taxonomic classification and biological functioning of bats.
Moralistic:	Concern for the right and wrong treatment of bats, with strong opposition to presumed cruelty toward bats.
Negativistic:	Orientation toward active avoidance of bats as a result of dislike or fear and their conservation.
Naturalistic:	Interest in direct outdoor recreational contact and enjoyment of bats.
Utilitarian:	Interest in the practical value of bats or the subordination of bats for the material benefit of humans.

Table 3.2: Section details of the structured questionnaire

Section (Number of Questions)	Description
Demographic (3)	Socio-demographic information: Gender, Age, Education level (Class in school)
Knowledge (13)	Knowledge about bats was measured using two methods; i) Previous Knowledge - School children were asked 13 factual questions about bats using True or False. ii) Knowledge gain - the same questions were re-administered to selected group immediately after lesson presentation as post-test.
Myths/Cultural beliefs (8)	To assess acceptance of myths and cultural beliefs (identified from literatures), students were asked to answer True/False to each belief or mythical statement.
Attitudes (23)	To assess attitudes, two methods were used; i) A 23 Likert-scale-type questions to measure 7 attitude dimensions according to Kellert (1996) to investigate how these various attitude dimensions are individually affected by gender and level of education (class in school). ii) The same questions were re-administered as post-test after the lesson presentation to selected students. This is to measure attitudinal shift from negative to positive or otherwise.
Information	To identify where school children get most of their information about bats
Risks and Perceived Risk (5)	To established the level of risks and perceived risk of having contact or encountering with bat by the children.

The designed educational unit on bats was presented within 45 minutes in a classroom setting to 180 randomly selected students (based on 1:30 teacher-student ratio) who were previously administered questionnaire (pre-test) from the six selected schools. Knowledge and attitude section of the same questionnaire was re-administered as post-test to them immediately after the lesson presentation. Their previous questionnaires (pre-test) were traced back using class register numbers provided. These were compared with their post-test to ascertain whether change had occurred or not.

3.13 Validity and Reliability of the Questionnaire

The validity of the questionnaire was established through review by an expert in the field of Zoology, two experts in biology education as well as one expert in the field of psychology all with Ph.D minimum qualification in Ahmadu Bello University Zaria. All were ask to evaluate whether the items in each section were relevant to the goal of the questionnaire. Their comments and suggestions led to the reframing and replacing of not appropriate statements.

A pilot study was conducted with 60 students (primary, junior and senior secondary school levels) to ascertain the reliability of the instrument. The reliability coefficient of the instrument was found to be 0.61 using Guttman Split half method (Thorndike and Hagen, 1997), confirmed the reliability of the instrument.

3.14 Statistical Analysis

Data obtained during ecological survey were analyzed using simple descriptive statistics. Chi-square was used to analyze the questionnaire responses and also to

determine roost preference of bats. To find if there is attitudinal change among the selected school children exposed to educational unit on bats, the pre-test and post-test data collected through questionnaire were subjected to Mann-Whitney *U* test to determine if there is any significant change from negative to positive in favour of bats conservation. Summary of the analysis is presented in Table 4.17. P-value of <0.05 was considered significant. All the analyses were conducted using SPSS statistical package version 20.

CHAPTER FOUR

4.0 RESULTS

4.1 Bats Roosts in Schools surveyed

Internal and external inspections of all public primary and secondary school buildings in Zaria metropolis during field surveys in August to November resulted in the location of 21 roosts (Table 4.1). Bat roosts were found in 21 (28%) of the 75 public schools spread across all the 7 educational district (Table 4.1) within Zaria metropolis. Out of the 51 primary schools surveyed, 9 (18%) had bats roosts while 12 (50%) of the 24 secondary schools were occupied by bats. Five schools were inhabited by bats in Tudun Wada district, 4 in Pada district, 2 in Dambo district, 1 in Rafin Albasa district and in 3 schools each in Kaura district, Unguwan Dankali district and Sabon Gari district (Table 4.1).

Bats guano was the common evidence discovered during the survey to establish bats presence in all the schools visited (Table 4.2). All schools identified with bat roosts had either multiple pellets of moist, soft guano which hinted that it was fresh, or dried guano. These were stuck to a wall by cobwebs under identifiable holes, in pile under a damaged ceiling or sprinkled over school items. Other evidence of school being used by bats as discovered during the surveys included urine stains on ceilings, bats noise, acrid pungent odour, dead bats on the floors and live bats seen during emergence observations (Table 4.2). Megachiroptera were found to roosted specifically on mango trees while Microchiroptera roosted inside roof space (Table 4.2).

Table 4.1: Number (%) of public primary and secondary schools occupied by roosting bats in Zaria metropolis

	Primary Schools		**Secondary Schools**		**Total**	
Districts	Surveyed	Occupied	Surveyed	Occupied	Surveyed	Occupied
Pada	14	1	7	3	21	4 (19)
Kaura	11	2	3	1	14	3 (21)
Rafin Albasa	10	1	1	0	11	1 (9.0)
Ung. Dankali	5	1	2	2	7	3 (43)
Tudun Wada	8	3	4	2	12	5 (42)
Dambo	3	1	1	1	4	2 (50)
Sabon Gari	-	-	6	3	6	3 (50)
Total	**51**	**9 (18%)**	**24**	**12 (50%)**	**75**	**21 (28%)**

Table 4.2: Results of field survey showing the established evidence of bats presence at each site.

Schools (Roost sites)	Suborder	Evidence of use	Roost location
Ahamdu Fatika P.S*	Microchiroptera	G, Us, N, O, Lb	Roof space
Adamu Dikko P.S*	Microchiroptera	G, Us, N, O, Lb	Roof space
Haruna Soba P.S*	Microchiroptera	G, Us, N, O, Lb	Roof space
Sani Adamu P.S*	Microchiroptera	G, Us, N, O, Lb	Roof space
Nuhu Baturen Makaratn P.S	Microchiroptera	G, Lb	Roof space
LT. Col. M. Jumare P.S	Microchiroptera	G	Roof space
Waziri Lawal Township P.S*	Microchiroptera and Megachiroptera	G, Bc, N, O, Lb	Roof space, Tree
Ahmadu Gyallesu P.S*	Microchiroptera	G, Us, Bc, N, O, Lb	Roof space
Isan Nabawa P.S	Microchiroptera	G, Lb	Roof space
Barewa College Zaria	Microchiroptera	G, Lb	Roof space
Commercial College Zaria*	Microchiroptera	G, Us, Bc, N, O, Lb	Roof space
Science School Kufena	Microchiroptera	G, O, Lb	Roof space
GGSS Dogon Bauchi	Microchiroptera	G, Lb	Roof space
GSS Chindit Barrack*	Microchiroptera	G, Us, N, O, Lb	Roof space
Alhuhuda College Zaria	Microchiroptera	G, Us, O, Lb	Roof space
GGSS Kofan Gayan*	Microchiroptera and Megachiroptera	G, Us, Bc, N, O, Lb	Roof space, Tree
GSS Kofan Jatau	Microchiroptera	G, O	Roof space
GSS Zaria*	Microchiroptera	G, Us, Bc, N, O, Lb	Roof space
GSS Tudun Jukun	Microchiroptera	G	Roof space
GGSS (WTC) Zaria*	Microchiroptera and Megachiroptera	G, Us, N, O, Lb	Roof space, Tree
GSS Dakace	Microchiroptera	G, Us, Lb	Roof space

Keys:
G = Guano; **Us**; Urine stains; **Bc** = Bat carcass; **N** = Noise; **O** = Odour; **Lb** = Live bat(s);
* = Bat roost also confirmed by school management, **P.S** = Primary school

The visual emergence counts conducted in schools with bats evidence yielded an estimate of emerging bats that varied between 3 to more than 300 per school, and were observed to use multiple exit points when emerging from their roosts (Table 4.3). No bats were found to emerged from three schools (sites), namely, Lt. Col. Muhammad Jumare primary school, GSS Kofan Jatau and GSS Tudun Jukun, there was, however, confirmed evidence of these schools being used by bats (Table 4.2; Table 4.3). Bats emerged from their roosts on average of 20 minutes after sunset (Table 4.3).

Chi-square test revealed that age of the building (χ^2=5.461, df=1, P=0.019) and nearness to water body (χ^2=13.829, df=1, P=<0.001) were significant characteristics (Table 4.4) that attracted bats to the schools.

4.2 Nuisances Associated with Roosting Bats in the Schools surveyed

During the survey inspections, schools with colony size >50 bats (Table 4.3) were found to encounter different kinds of nuisance and damages caused by roosting bats which were difficult to quantify but described. Bat guano (faecal waste) was found in some surveyed schools to accumulate inside ceiling over time which eventually resulted into the collapse of interior structure (Plate I). There were also some cases where bat guano continuously dropped inside classrooms, offices, library (Plate II), and on various school items such as textbooks, documents and chairs (Plate III). Bats guano deposits mixed with their urine or rain water overtime were found in some schools to have soaked and stained the area of the ceiling affected, waste dripping and the eventual ruining of the classroom insulation accompanied with distinctive acrid pungent odour (Plate IV).

Table 4.3: Estimated population size and mean emergence time of each established roost

Schools (Roost sites)	Maximum count of emerging bats	Number of exits	Mean emergence time (Minutes)
Ahamdu Fatika P.S*	63*	Multiple	15.7
Adamu Dikko P.S*	153+*	Multiple	17.8
Haruna Soba P.S*	118+*	Multiple	21.7
Sani Adamu P.S*	109+	Multiple	19.3
Nuhu Baturen Makaratn P.S	7*	Single	12.8
LT. Col. M. Jumare P.S	-	-	-
Waziri Lawal Township P.S*	73*, 322+**	Multiple	31.0
Ahmadu Gyallesu P.S*	115+*	Multiple	21.0
Isan Nabawa P.S	3*	Single	10.7
Barewa College Zaria	31*	Multiple	21.0
Commercial College Zaria*	124+*	Multiple	22.0
Science School Kufena	22*	Multiple	13.0
GGSS Dogon Bauchi	3*	Single	12.7
GSS Chindit Barrack*	103+*	Multiple	21.7
Alhuhuda College Zaria	77+*	Multiple	22.7
GGSS. Kofan Gayan*	58*, 31+**	Multiple	26.0
GSS. Kofan Jatau	-	-	-
GSS Zaria*	121+*	Multiple	27.0
GSS Tudun Jukun	-	-	-
GGSS Zaria*	52*, 38**	Multiple	29.0
GSS Dakace	13*	Multiple	16.0
			20 minutes

Keys:

* = Microchiropterans, ** = Megachiropterans, **P.S** = Primary school

+ = suspected to be more than the maximum count

Table 4.4: Roosting preference of bats in schools of the study area

Characteristics	χ^2	**df**	**P-value**
Disturbance Level	0.148	1	0.700ns
Age of Building	5.461	1	0.019*
Usage Status	1.596	1	0.206ns
Illumination	0.177	1	0.674ns
Surrounding Vegetation	0.21	2	0.901ns
Roost Surrounding	2.118	1	0.146ns
Distance to Water Body	13.829	1	<0.001**
Exit Height	0.305	1	0.581ns

Keys:

***** = Significant ($P \leq 0.05$)

****** = Highly significant ($P \leq 0.01$)

ns = Not significant ($P \geq 0.05$)

a

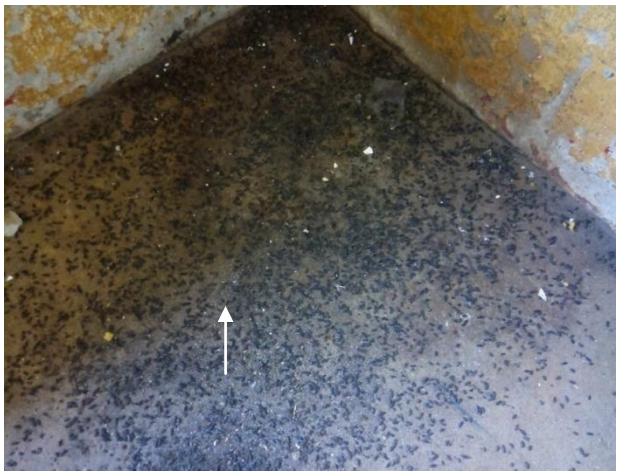
b

c

d

Plate I: Different stages of ceiling deterioration observed in different surveyed schools resulted from long time accumulation of bats droppings (a) sagged ceiling about to drop in Sani Adamu P.S, (b) a gaped ceiling, (c and d) a tattered and a completely removed ceiling in an effort to evict bats in Adamu Dikko P.S.

a



b

c

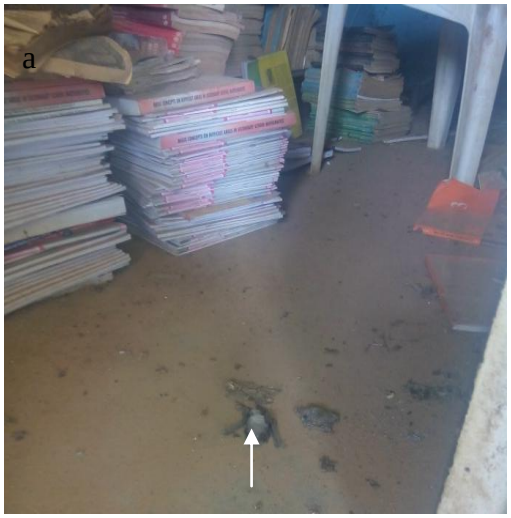
d

e

Plate II: Patterns of bat droppings within school buildings in Zaria metropolis (a) accumulated bats guano on the office floor in GSS Zaria, (b) scattered bat guano at one corner of a classroom's floor in Haruna Soba P.S, (c and d) falling bats guano hanging freely on cobweb in GGSS Kofan Gayan, (e) bats guano landing on top of a chalkboard that is still in active use in GGSS Zaria.

a

b



c

d

Plate III: Some cases of bat droppings on school property in some surveyed schools (a, b and c) scattered bat droppings on textbooks with carcass of a juvenile bat in GSS Zaria, (d) accumulated bats guano on unidentified school documents and on a chair inside an abandoned office in GSS Chindit Barrack.

a

b

c

d

Plate IV: Staining patterns on ceiling caused by accumulated bats guano mixed with their urine or rain water as noticed in some surveyed schools (a) stain at far end of a ceiling which keep spreading gradually in Ahmadu Fatika P.S, (b) a stained ceiling, weaken and eventually holed in Haruna Soba P.S, (c) bats waste stains ruptured the far end of a classroom ceiling in Adamu Dikko P.S, (d) a stained ceiling ripped open by school management in attempt to apply pesticide to the roosting bats in Commercial College Zaria.

Cases of bats carcass were discovered on the floor during the survey in some schools in and outside some classrooms, office, library and store of both dried dead ones (Plate V) and freshly dead ones (Plate VI). Roosting bats in some schools were also found to render some classroom non-conducive for teaching and learning activities (Plate VIII), taking over some classroom and other built structures (Plate VII) and in some cases producing a very distracting noise in and outside the classroom (Plate IX).

Though no attempt was made to capture bats for identification, two bats species were however identified through their carcass discovered during the survey. They were *Rhinopoma* spp. *(*Mouse-tailed b at) (Plate V) and *Eidolon helvum* (African straw-coloured fruit-bat) (Happold, 1987) (Plate VI).

The ceiling of a, b and c of Plate VIII were deliberately holed, tattered and removed respectively by school management in an attempt to do away with bats offensive odour, squeaking and scratching while lessons is going on.

In all the school surveyed, no wall, roof or rafter damages were noticed to be associated with roosting bats. No nuisance issues were discovered in schools with solitary bats.

a

b

c

d

Plate V: Instances of dried dead Microchiropterans found on the floor in some schools surveyed (a) dried carcass of *Rhinopoma* spp. on the assembly ground Commercial College Zaria, (b) a carcass of a juvenile bat in a school garden in GGSS Kofan Gayan, (c) a carcass of *Rhinopoma* spp. on the floor of abandoned classroom Ahmadu Gyallesu, (d) a carcass on the floor of abandoned office in GSS Zaria.

a

b

c

d

Plate VI: Some cases of freshly dead *Eidolon helvum* discovered in Waziri Lawal Township P.S (a) a dead *Eidolon helvum* found inside nursery pupil's playground, (b and c) dead *Eidolon helvum* found outside a primary school class, (d) a freshly dead *Eidolon helvum* being toss around by school children with their bare hands inside a school premises.

a

b

c

d

Plate VII: Examples of school buildings taken over by roosting activities of bats in some of the schools surveyed (a) a block in Commercial College Zaria having two classrooms with good wall, roof and floor, (b) a block of two classrooms in Adamu Dikko P.S with a weak roof, (c) a school library in GSS Zaria, (d) two blocks each having two classrooms in Sani Adamu P.S.

a

b

c

d

Plate VIII: How roosting bats interferes with teaching and learning activities in some surveyed schools in Zaria (a) a classroom with holed ceiling oozing bats odour that disorganising pupil's sitting arrangement in Haruna Soba P.S, (b) a classroom with half-fallen half-tattered ceiling in Sani Adamu P.S, (c) a ceiling of a classroom completely removed in Sani Adamu P.S, (d) a sagged, about to fall ceiling resulted from excessive weight exerted by long time guano accumulation Adamu Dikko P.S.

a

b

Plate IX: Emerging bats during evening emergence count, emitting high-pitched sound in Waziri Lawal Township P.S. Though very interesting to watch, their noise however distract any evening activity in the school.

4.3 Knowledge and Attitudes of School Children in Zaria towards Bats

4.3.1 Demographic characteristics of the respondents

Of the 384 questionnaires distributed, a total of 376 respondents completed and returned the self administered questionnaires covering primary pupils (class 5-6), JSS and SSS students in public pre-tertiary schools in the study area. The returned questionnaire gave a response rate of 97.9%. The overall high rate of return could be as a result of assistance rendered by science-teachers of the selected schools during questionnaire administration, and or the high level of interest by respondents on the research topic. Of these, 194 (51.6%) were boys, while 182 (48.4%) were girls (Table 4.5). Age group was not included among the demographic variables because of its conformity with level of education (class in school).

4.3.2 Source of information about bats

When asked for their sources of information about bats, respondents indicated that they obtained information about bats from all of the sources listed in the questionnaire as well as additional sources not listed (Figure 4.1). Over half of all respondents (79%) obtained information about bats from their family and friends. Twenty six percent obtained information from library/books. Nearly half of respondents got their information from radio/television (43%) but only 9% of the respondents admitted they got their knowledge of bats from their school teachers.

Table 4.5: Demographic characteristics of the respondents

Demographic Factor	Indicator	Frequency	Percentage (%)
Gender	Male	194	51.6
	Female	182	48.4
		376	**100**
Class in school	Primary 5 – 6	124	33
	JSS 1 – 3	125	33.2
	SSS 1 – 3	127	33.8
		376	**100**
Age groups	Below 12 years	122	32.4
	12 - 14 years	113	30.1
	15 - 17 years	122	32.4
	18 years and above	19	5.1
Total		**376**	**100**

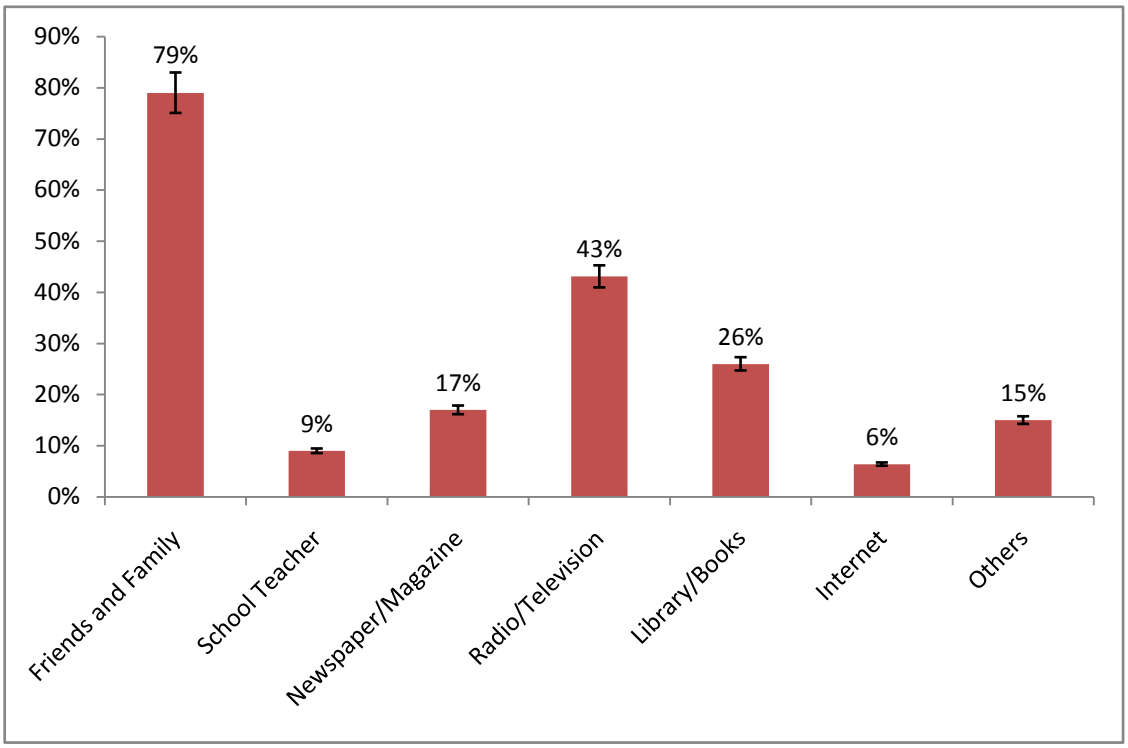


Figure 4.1: Sources that primary and secondary school students in Zaria used to get their information about bats

4.3.3 Self-assessed knowledge about bats

When asked to rate how much they knew about bats, 52.1% of the respondents felt that they knew very little while 37.8% felt they knew nothing. The remaining respondents presumed themselves in the top categories as knowing ‘a great deal’, ‘a fair amount’ and ‘some’ (Figure 4.2). Their overall ‘factual knowledge’ was found to be indeed low on the basis of their percentages of wrong answers per question (Table 4.6).

4.3.4 Knowledge about bats biology and their ecological roles

The analyses of student’s responses to each knowledge question (Table 4.6) revealed that, 95.8% regarded bats as birds while 75.8% of the respondents regarded bats as blinds and, live in tress and buildings only (95.5%). Regarding the ecological role of bats, only 8.5% of the respondents believed that bats were good for environment and helped in seeds dispersal (28.5%). Ninety six percent agreed that bats were capable of transmitting diseases, and were capable of attacking people (80.3%) while 41.5% claimed that Ebola disease was only transmitted by bats. When asked whether bats are wild animals. Slightly more than half of the respondents (58.8%) agreed with the statement that bats were wild animals, 6.69% were of belief that bats can have more than two babies per year and can live more than five years (38.9%). Only 19.1% of the respondents regarded bats as mammals and that some bats only depended on insects as their food (23.1%). Table 4.7 reveal that, there were significant differences between boys and girls responses as regard to their factual knowledge on bats biology (i.e. question 1- 5) except in question 1. On questions regarding to ecological roles of bats (i.e. question 6 – 10) and bats roles in disease transmission (i.e. question 11 – 13)

there were no significant differences between boy's and girl's responses with the exception of question 10 and 12 respectively (Table 4.7). Table 4.8 shows that, there were significant differences among the education level (class in School) in all the questions regarding bats biology, their ecological roles and roles in disease transmission. In all the responses on factual knowledge about bats, girls had higher percentages of wrong answers than boys (Table 4.7). SSS students had higher percentages of correct answers than primary and JSS students (Table 4.8).

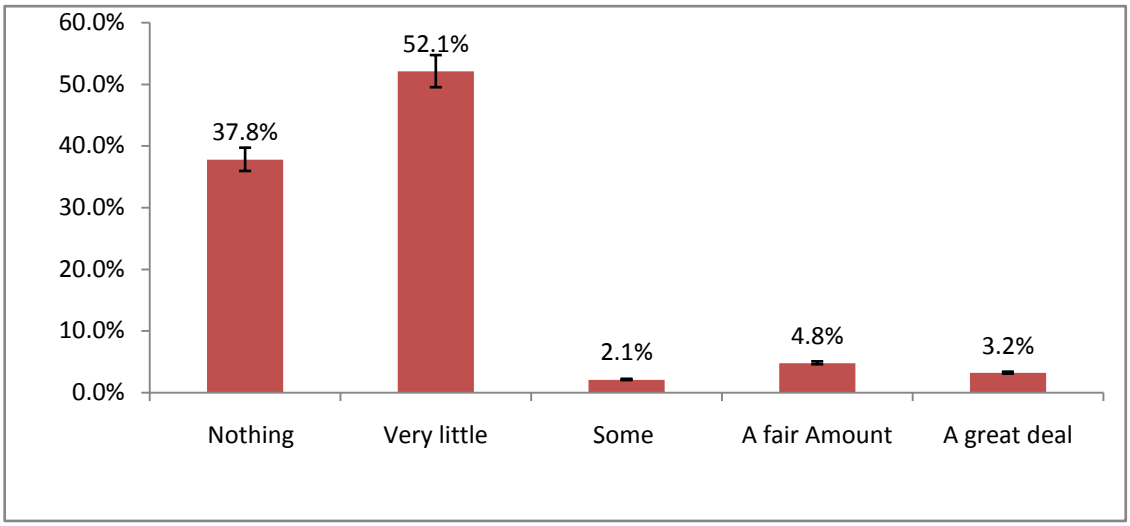


Figure 4.2: School children self-assessed knowledge in Zaria regarding bats

Table 4.6: Overall percentages of "correct answer (CA)" and "wrong answer (WA)" of school children in Zaria regarding their knowledge about bats

	Total Percentages (%)	
Items	**CA**	**WA**
Q1. Bats are birds	4.2	95.8
Q2. Bats have more than 2 babies each year	6.6	93.4
Q3. Bats can live up to 5 years and above	38.9	61.1
Q4. Bats are mammals	19.1	80.9
Q5. Bats are blind	24.2	75.8
Q6. Some bats only eat insects	23.1	76.9
Q7. Some bats help to spread seeds from trees	28.5	71.5
Q8. Bats live in trees and building only	4.5	95.5
Q9. Bats are examples of wild animals	58.8	41.2
Q10. Bats are good for the environment	8.5	91.5
Q11. Bats can spread diseases	96.0	4
Q12. Bats attack people	19.7	80.3
Q13. Bats are the only transmitter of Ebola virus	58.5	41.5

Table 4.7: Knowledge of school children in Zaria about bats based on gender

Questions	Gender		Total (%) (n= 376)	χ^2	df	P value
	Boys (%) (n=194)	Girls (%) (n = 182)				
Q 1. Bats are birds	182 (93.8)	178 (97.8)	360 (95.7)	3.665	2	0.056ns
Q2. Bats have more than 2 babies each year	134 (69.1)	159 (87.4)	293 (77.9)	21.799	2	<0.001**
Q3. Bats can live up to 5 years and above	124 (63.9)	68 (37.4)	192 (51.1)	57.402	2	<0.001**
Q4. Bats are mammals	49 (25.1)	26 (14.3)	75 (19.9)	10.751	2	0.005**
Q5. Bats are blind	123 (63.4)	138 (75.8)	261 (69.4)	19.710	2	<0.001**
Q6. Some bats only eat insects	45 (23.2)	41 (22.5)	86 (22.9)	0.489	2	0.783ns
Q7. Some bats help to spread seeds from trees	62 (32.0)	45 (24.7)	107 (28.5)	5.486	2	0.064ns
Q8. Bats live in trees and building only	183 (94.3)	176 (96.7)	359 (95.5)	1.225	2	0.268ns
Q9. Bats are examples of wild animals	112 (57.7)	109 (59.9)	221 (58.8)	1.232	2	0.540ns
Q10. Bats are good for the environment	21 (10.8)	11 (6.0)	32 (8.5)	10.456	2	0.005**
Q11. Bats can spread diseases	188 (96.9)	173 (95.1)	361 (96.0)	2.386	2	0.303ns
Q12. Bats attack people	128 (66.0)	140 (76.9)	268 (71.3)	48.280	2	<0.001**
Q13. Bats are the only transmitter of Ebola virus	79 (40.7)	77 (42.3)	156 (41.5)	0.097	2	0.755ns

Keys:

***** = Significant ($P \leq 0.05$)
****** = Highly significant ($P \leq 0.01$)
ns = Not significant ($P > 0.05$)

Table 4.8: Knowledge of school children in Zaria about bats based on level of education (Class in school)

Variable	Level of Education			Total (%) (n = 376)	χ^2	df	P value
	Primary (%) (n = 124)	JSS (%) (n = 125)	SSS (%) (n = 127)				
Q1. Bats are birds	124 (100.0)	125 (100.0)	111 (87.4)	360 (95.7)	32.764	2	<0.001**
Q2. Bats have more than 2 babies yearly	122 (98.4)	100 (80.0)	71 (55.9)	293 (77.9)	77.994	4	<0.001**
Q3. Bats can live up to 5 years and above	6 (4.8)	85 (68.0)	101 (79.5)	192 (51.1)	179.035	4	<0.001**
Q4. Bats are mammals	0 (0.00	12 (9.6)	63 (49.6)	75 (19.9)	123.444	4	<0.001**
Q5. Bats are blind	118 (95.2)	88 (70.4)	55 (43.3)	261 (69.4)	83.433	4	<0.001**
Q6. Some bats only eat insects	0 (0.0)	17 (13.6)	69 (54.3)	86 (22.9)	116.560	4	<0.001**
Q 7. Some bats help to spread seeds	9 (7.3)	22 (17.6)	76 (59.8)	107 (28.5)	123.428	4	<0.001**
Q8. Bats live in trees and building only	124 (100.0)	125 (100.0)	110 (86.6)	359 (95.5)	34.909	2	<0.001**
Q9. Bats are examples of wild animals	43 (34.7)	84 (67.2)	94 (74.0)	221 (58.8)	87.940	4	<0.001**
Q10. Bats are good for the environment	0 (0.0)	5 (4.0)	27 (21.3)	32 (8.5)	57.647	4	<0.001**
Q11. Bats can spread diseases	124 (100.0)	112 (89.6)	125 (98.4)	361 (96.0)	21.890	4	<0.001**
Q12. Bats attack people	105 (84.7)	86 (68.8)	77 (60.6)	268 (71.3)	23.066	4	<0.001**
Q13. Bats are the only transmitter of Ebola virus	105 (84.7)	35 (28.0)	16 (12.6)	156 (41.5)	148.311	2	<0.001**

Keys:

***** = Significant ($P \leq 0.05$)

****** = Highly significant ($P \leq 0.01$)

4.3.5 Acceptance of cultural beliefs about bats

Cultural beliefs identified from literature were tested for acceptance by school children in Zaria. Figure 4.3 shows that 100% of the girls and over half of the boys accepted that bats are symbols of witchcraft and are useless. Over half of the total respondents (86.3% boys and 87.6% girls) accepted that bats were misfortune and useless animals (96.9% boys and 100% girls), and that they sucked human blood (90.2% boys and 41.2% girls). None of the boys (0.0%) accepted that bats were likeable, brought luck or bats were cursed by God but a very few percentage of girls accepted such beliefs. In all, girls had higher percentages of agreement with statements on cultural beliefs about bats than the boys (Figure 4.3).

4.3.6 Risk and perceived risk

Overall, only 5.2% admitted to have killed a bat before, and none of them agreed to have been bitten or scratched by a bat before. While the risk and perceived risks of encountering bats appeared fairly low, boys had actual encounters with bats more than did girls, even though the girls showed higher percentages of perceived risks of getting in contact with bats (Figure 4.4).

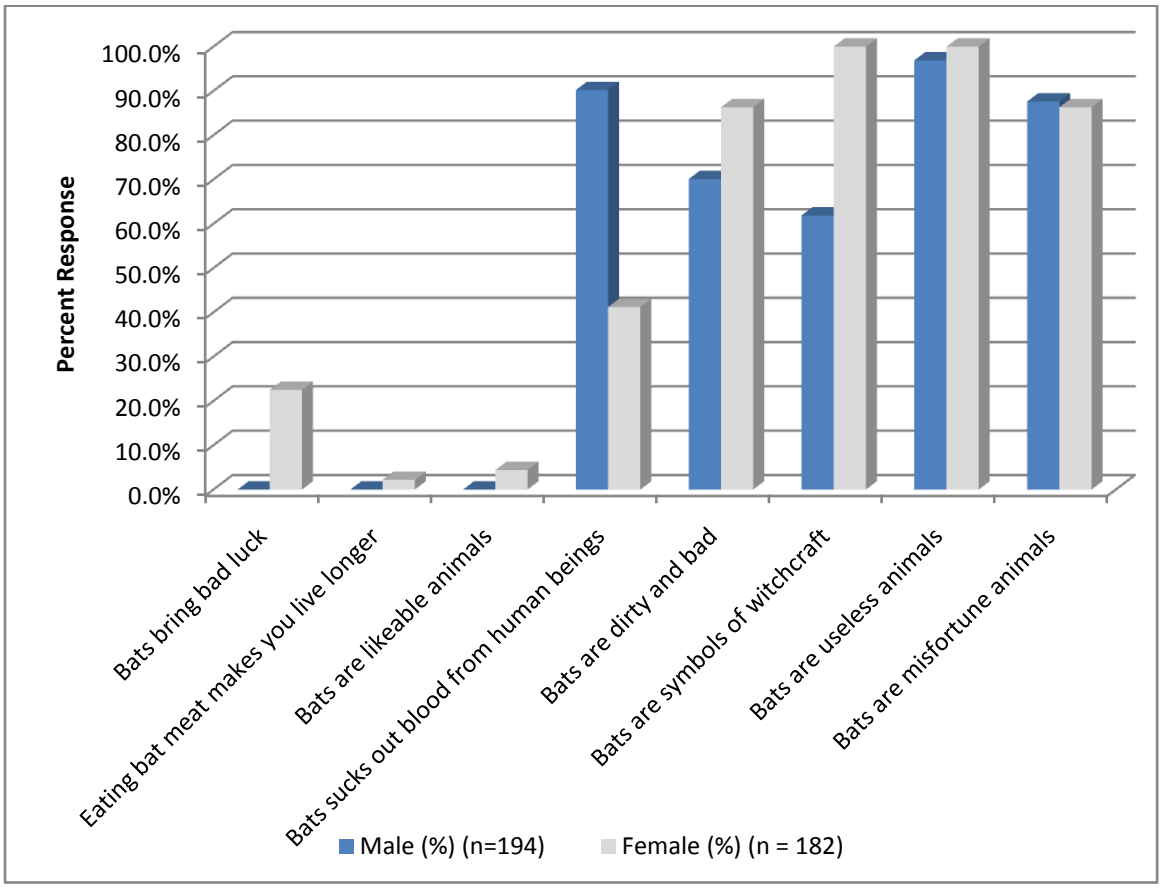


Figure 4.3: Acceptance of Cultural Beliefs by school children in Zaria about bats

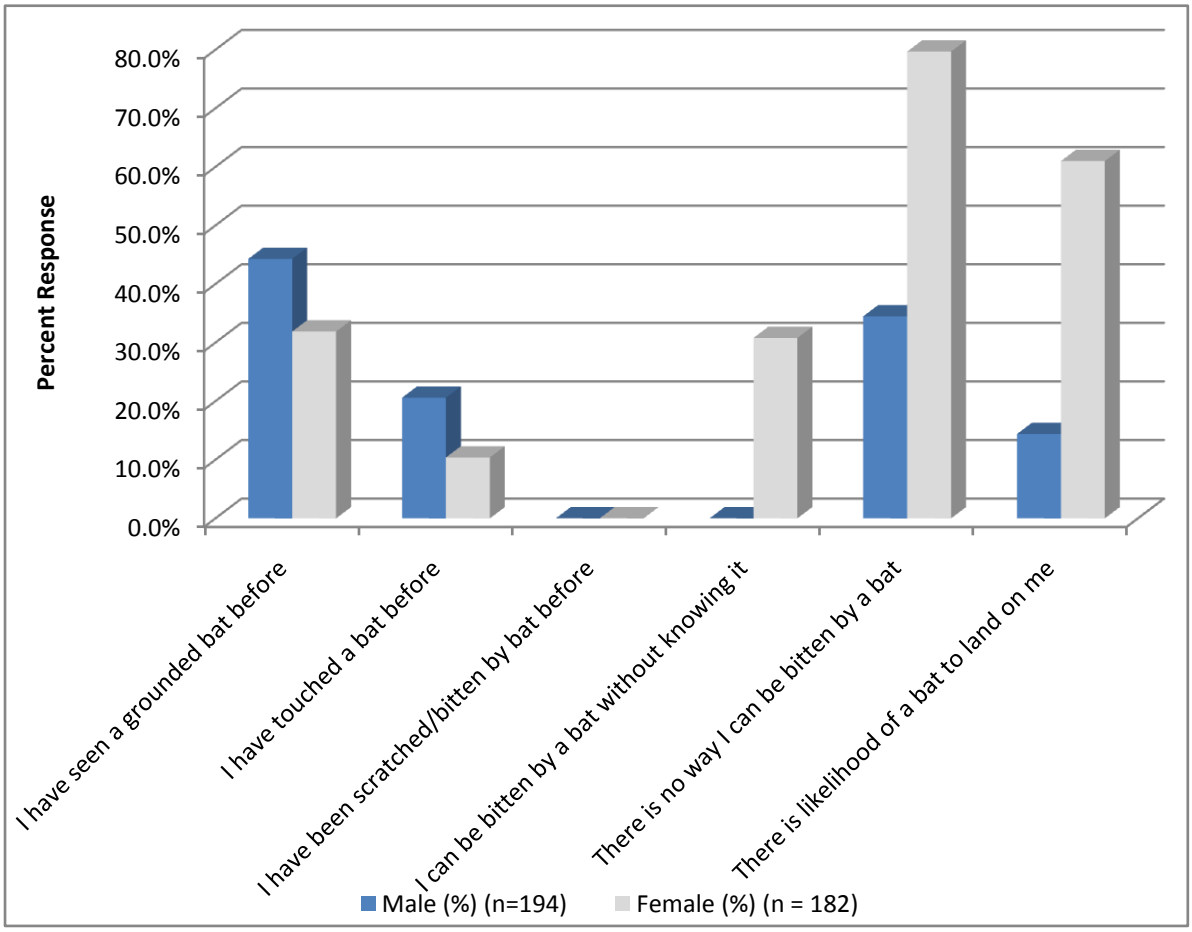


Figure 4.4: Risks and perceived risks about bats among school children in Zaria

4.3.7 Attitudes sub-measures of school children in Zaria towards bats

Utilitarian Sub-measure: Relatively few students expressed utilitarian interests (Figure 4.5). Only 6.4% agreed that bats were good for some tress, 22.6% thought that bats could be used to encourage tourists to come to Zaria while only 6.1% of students agreed to the statement "Bats faeces should be used as manure in farms" (Figure 4.5). There were high significant differences between the genders (χ^2 = 35.163, df = 2, P=<0.001) and among the education level (χ^2 = 19.284, df = 4, P=<0.001) in response to statements on material benefits of bats to humans (Table 4.9). Boys had significantly higher scores than girls while the SSS students had relatively higher scores than primary and JSS students.

Negativistic Sub-measure: Majority of the students (80.3%) agreed that bats were ugly animals, 62.8% did not like having bats where they lived and that they felt tense on seeing bats (58.5%), and 45% agreed that bats were nuisance animals on earth (Figure 4.5). Responses indicated that negativistic attitude decreased significantly with increasing level of education (χ^2 = 47.264, df = 4, P=<0.001) (Table 4.10). The gender difference was large; girls showed significantly higher negativistic score than did boys (χ^2 = 96.872, df = 2, P=<0.001) (Table 4.10).

Naturalistic Sub-measure: Of all the school children, 22.1% of them agreed with statement "I would prefer to live in a town with bats" while only 2.1% of them agreed that they could live in places where there were lots of bats (Figure 4.5). The naturalistic interests decreased significantly with increase in level of education (χ^2 = 103.061, df = 6, P=<0.001). Girls had significantly high scores on naturalistic statements than boys (χ^2 = 103.061, df = 6, P=<0.001) (Table 4.11.).

Table 4.9: Utilitarian attitude in relation to gender and level of education among school children in Zaria (n=376)

Category	**Indicator**	**N**	**% A**	**% U**	**% DA**	χ^2	**df**	**P value**
Gender	Boys	194	20.96	6.70	72.34	35.163	2	<0.001**
	Girls	182	1.83	10.81	87.36			
Education	Primary	124	5.11	2.96	91.94	19.284	4	0.001**
	J.S.S	125	17.33	10.40	72.27			
	S.S.S	127	12.6	12.60	74.8			

Keys:

A= Agreed + strongly agree, **U**=Undecided, **DA**=Disagreed + strongly disagreed

n = Number of respondents

****** = Highly significant ($P \leq 0.01$)

Table 4.10: Negativistic attitudes in relation to gender and level of education among school children in Zaria (n=376)

Category	**Indicator**	**N**	**% A**	**% U**	**% DA**	χ^2	**df**	**P value**
Gender	Boys	194	38.53	23.45	38.02	96.872	2	<0.001**
	Girls	182	86.68	8.79	4.53			
Education	Primary	124	77.82	17.14	5.04	47.264	4	<0.001**
	J.S.S	125	56.40	22.40	21.2			
	S.S.S	127	51.57	9.65	38.78			

Keys:

A= Agreed + strongly agree, **U**=Undecided, **DA**=Disagreed + strongly disagreed

n = Number of respondents

****** = Highly significant ($P \leq 0.01$)

Table 4.11: Naturalistic attitudes in relation to gender and level of education among school children in Zaria (n=376)

Category	**Indicator**	**N**	**% A**	**% U**	**% DA**	χ^2	**df**	**P value**
Gender	Boys	194	60.31	9.54	30.15	56.451	2	<0.001**
	Girls	182	93.13	2.75	4.12			
Education	Primary	124	100.00	0.00	0.00	171.19	4	<0.001**
	J.S.S	125	93.20	2.40	4.40			
	S.S.S	127	36.22	16.14	47.64			

Keys:

A= Agreed + strongly agree, **U**=Undecided, **DA**=Disagreed + strongly disagreed

n = Number of respondents

****** = Highly significant ($P \leq 0.01$)

Dominionistic Sub-measure: More than half of the students (64.1%) agreed that the number of bats should be controlled by people, and where bats live (41.5%). Less than half of the students (45.7%) agreed that bats should not be allowed to fly where they want, and should not also be allow to eat whatever they want (13.8%) (Figure 4.5). There were significant differences between all the demographic groups (genders and education level) (P=<0.001) (Table 4.12).

Ecoscientistic Sub-measure: Majority of the school children (81.10%) wished to know more about what bats eat, and would like to know how bats are useful to human being (52.9%), slightly less than half of the students (49.7%) thought that children need to learn more about bats in schools (Figure 4.5). There were significantly high differences among the gender and level of education (P=<0.001). Boys showed higher percentages of ecoscientistic interests than did girls (Table 4.13).

Aesthetic Sub-measure: Majority of the students expressed aesthetic interest in bats. For example, 76.3% liked to see pictures of bats, and agreed that bats were a symbol of natural beauty (67.8%). However, less than half of the students (41.5%) agreed with the statement "Watching bats fly around at sunset is beautiful" (Figure 4.5). There were significant differences among all the demographic groups (gender and level of education). Girls had higher aesthetic scores than boys (Table 4.14).

Table 4.12: Dominionistic interests in relation to gender and level of education among school children in Zaria (n=376)

Category	**Indicator**	**N**	**% A**	**% U**	**% DA**	**χ^2**	**df**	**P value**
Gender	Boys	194	45.62	3.87	50.77	12.629	2	0.002**
	Girls	182	36.68	14.15	49.18			
Education	Primary	124	57.66	10.08	32.26	29.225	4	<0.001**
	J.S.S	125	38.40	10.20	51.40			
	S.S.S	127	28.15	6.30	65.55			

Keys:

A= Agreed + strongly agree, **U**=Undecided, **DA**=Disagreed + strongly disagreed

n = Number of respondents

****** = Highly significant ($P \leq 0.01$)

Table 4.13: Ecoscientistic interests in relation to gender and level of education among school children in Zaria (n=376)

Category	**Indicator**	**N**	**% A**	**% U**	**% DA**	χ^2	**df**	**P value**
Gender	Boys	194	72.44	4.64	22.92	71.219	2	<0.001**
	Girls	182	47.32	7.33	45.35			
Education	Primary	124	87.63	1.88	10.48	78.772	4	<0.001**
	J.S.S	125	63.47	5.33	31.20			
	S.S.S	127	33.33	10.50	56.17			

Keys:

A= Agreed + strongly agree, **U**=Undecided, **DA**=Disagreed + strongly disagreed

n = Number of respondents

****** = Highly significant ($P \leq 0.01$)

Table 4.14: Aesthetic attitudes in relation to gender and level of education among school children in Zaria (n=376)

Category	**Indicator**	**N**	**% A**	**% U**	**% DA**	χ^2	**df**	**P value**
Gender	Boys	194	44.16	7.39	48.45	57.531	2	<0.001**
	Girls	182	80.77	6.04	13.19			
Education	Primary	124	61.83	11.56	26.61	15.39	4	0.004**
	J.S.S	125	66.13	7.20	26.67			
	S.S.S	127	57.74	1.57	40.68			

Keys:

A= Agreed + strongly agree, **U**=Undecided, **DA**=Disagreed + strongly disagreed

n = Number of respondents

****** = Highly significant ($P \leq 0.01$)

Moralistic Sub-measure: Most students agreed that bats should be protected on the ground that they were God's creature (71.8%), and 65.7% would like bats to be treated with respect because they were here before us. Thirty seven percent agreed that bats have the right to live as people, and therefore deserved protection (34.8%) (Figure 4.5). There were higher significant differences among the gender and level of education. Girls demonstrated more moralistic attitude than did boys (Table 4.15). Moralistic attitude decreased with increasing level of education (Table 4.15).

4.3.8 The overall attitudes of school children in Zaria towards bats

Figure 4.5 reveals that respondents were less concerned about the practical and material values of bats (utilitarian: 11.7% positive, 8.7% neutral and 79.6% negative); dislike, fear and avoidance of bats (negativistic: 61.8% negative, 16.4% neutral and 21.8% positive). Respondents were less interested in outdoor recreational contact with bats (naturalistic: 17.6% positive, 6.3% neutral and 76.2% negative), and less interested in mastering or control of bats (dominionistic: 41.3% positive, 8.9% neutral and 49.9% negative). More than half of the respondents wanted to know more about biological functioning of bats (ecoscientistic: 61.3% positive, 6.0% neutral and 32.8% negative), and interested in symbolic appeal of bats (aesthetic: 61.9% positive, 6.7% neutral and 31.4% negative). Slightly above half of the respondents showed concern on correct treatment of bats (moralistic: 52.4% positive, 13.6 neutral and 34.0% negative).

Table 4.15: Moralistic attitudes in relation to gender and level of education among school children in Zaria (n=376)

Category	**Indicator**	**N**	**% A**	**% U**	**% DA**	χ^2	**df**	**P value**
Gender	Boys	194	42.65	11.60	45.75	24.683	2	<0.001**
	Girls	182	62.77	15.66	21.57			
Education	Primary	124	60.48	17.74	21.77	16.324	4	0.003**
	J.S.S	125	50.40	14.20	35.40			
	S.S.S	127	46.46	8.86	44.69			

Keys:

A= Agreed + strongly agree, **U**=Undecided, **DA**=Disagreed + strongly disagreed

n = Number of respondents

****** = Highly significant ($P \leq 0.01$)

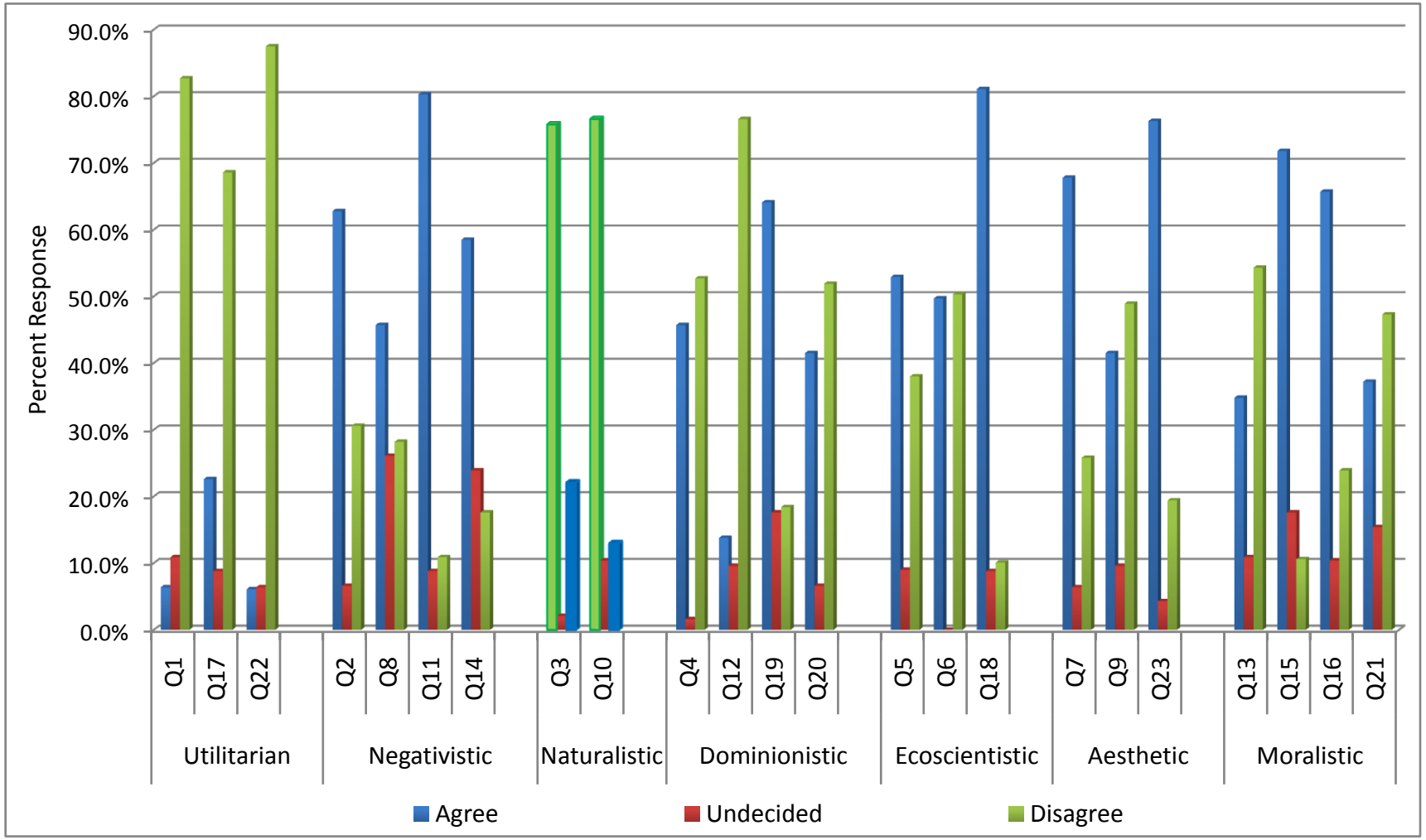


Figure 4.5: The overall attitudes of school children in Zaria toward bats based on Kellert (1996) typology

Key: Q = Question number as indicated in the questionnaire (Appendix V)

4.4 Effect of Education on School children's Attitudes towards Bat Conservation

The results of the pre-test and post-test questionnaire responses on knowledge about bats are presented Table 4.16. The greatest increase in knowledge was found in question 10 (Bats are good for the environment). More than 20% increase in knowledge of bats was found in question 1, 2 and 8. Almost all the students (95.6%) already knew the correct answer to question 11; hence only 3.8% increase was obtained as a result of knowledge acquired.

The pre-test and post-test mean ranks (Table 4.17) were 22.00 and 65.00 with sum of rank of 946.00 and of 2794.00 respectively. The overall attitudes of the selected school children towards bats significantly (P=0.025) improved positively.

Table 4.16**:** Frequencies of correct answers in pre-test and post-test (n=180)

Questions	**Pre-test Frequency (%)**	**Post-test Frequency (%)**	**Increase %**
Q 1. Bats are birds	7 (3.9)	53 (29.4)	25.5
Q2. Bats have more than 2 babies each year	14 (7.8)	57 (31.7)	23.9
Q3. Bats can live up to 5 years and above	62 (34.4)	93 (51.7)	17.3
Q4. Bats are mammals	31 (17.2)	59 (32.8)	15.6
Q5. Bats are blinds	39 (21.7)	59 (32.8)	11.1
Q6. Some bats only eat insects	32 (17.8)	68 (37.8)	20.0
Q 7. Some bats help to spread seeds from trees	52 (28.9)	89 (49.4)	20.5
Q8. Bats live in Trees and building only	7 (3.9)	57 (31.7)	27.8
Q9. Bats are examples of wildlife animals	101 (56.1)	133 (73.9)	17.8
Q10. Bats are good for the environment	12 (6.7)	112 (62.2)	55.5
Q11. Bats can spread diseases	172 (95.6)	179 (99.4)	3.8
Q12. Bats attack people	37 (20.6)	61 (33.9)	13.0
Q13. Bats are the only transmitter of Ebola virus	119 (66.1)	146 (81.1)	15.0

Table 4.17: Mann-Whitney *U* test analysis of mean scores of attitudinal change of the selected school children exposed to educational unit on bats

Variables	N	Mean Rank	Sum of Rank	Mann-Whitney	Z-value	P-value
Pre-test	180	22.00	946.00	946.000	-7.997	0.025*
Post-test	180	65.00	2794.00			

Key:

***** = Significant ($P \leq 0.05$)

CHAPTER FIVE

5.0 DISCUSSION

5.1 Bat Roosts in Public Primary and Secondary Schools in Zaria

As at the time of this research, Zaria Local Government Area had a total of 139 pre-tertiary schools (115 primary and 24 secondary). These schools are managed by 7 District Education Offices. The overall survey indicated that, bats use 28% (21) of public schools within the metropolis; 9 primary and 12 secondary schools located across all the 7 educational districts. *Eidolon helvum* (African straw-coloured fruit-bat) *and Rhinopoma* spp. (Mouse-tailed bat) were accidentally identified through their carcass found on the ground within school environment; hence it's likely that other species of bats were also roosting. *Rhinopoma* spp. is listed as "Least Concern" as it is widespread and is common in at least parts of its range, with no current identifiable major risks (IUCN, 2014.3). Human disturbance in roost sites and use of pesticides on to the species are not considered major threat at present (Auglanier and Palmeirim, 2008). *Eidolon helvum* on the other hand is listed as "Near Threatened" by IUCN because the species is in significant decline (but at a rate of less than 30% over three generations (approximately fifteen years). Though there were generally no major threats to this widespread and adaptable species, it is however, locally threatened in parts of its range by severe deforestation and more generally across West and Central Africa by hunting for food and medicinal use (Mickleburgh *et al*., 2008).

The number of bats per school ranged from 3 to >300. Megachiropterans and Microchiropterans were found to co-roost in GGSS Kofan Gayan, GGSS Zaria and Waziri Lawal Township Primary school while only Microchiropterans roost in the remaining schools. Megachiropterans were found to roost specifically on mango trees while Microchiropterans roost mainly in roof space (inside ceiling), Almost all the schools they occupied were old and mostly not more than 2 km away from the nearest water source, which indicates that residential buildings situated along water bodies may be under increased risk of adoption by bat colonies if eventually evicted from schools. The schools with bats population >50 were observed to show a greater evidence of use by bats, suggesting that, they harbour maternity colony while those with evidence of minor use may be used as either occasional day roosts or night roosts (Kunz and Reynold, 2003). Bats were found to emerge on the average of 20 minutes after sunset, a distinctive smaller value of 45 minutes after sunset reported by Jones and Rydell (1994). The variations of emergence time could be attributed to level of human activities around the bat roosts, disturbance level, distance to foraging site or inclement weather. The availability of multiple access points used by bats in the school that they occupied proves it difficult to school managements to evict them so easily. Bats roosting in school buildings in Zaria seem to be habituated to different kind of disturbances caused by normal school activities during the day, noises from people who play football in the evenings and normal traffic.

5.2 Nuisances and Damages Associated with Roosting Activities of Bats in Schools they Occupied in Zaria

Although the anecdotal records from Zaria LGEA and Zaria Inspectorate Division Kaduna State Ministry of Education reveals that, no bite or infection associated with bats has ever been recorded in their division, bats carcass incidentally found in schools environs during the survey are greater threat particularly to student's health as it increases the closeness and chances of bats-students contact and risk of being bitten by bat without the knowledge of the school authority. It is also possible that, school children may contract rabies or other deadly disease if infectious material from dead or diseased bat, such as saliva, gets directly into eyes, nose or open wound. Ademola (2012) reported that most pupils in Zaria are not hygienically sensitive in terms of hand washing; this can contribute to accidental hand-to-mouth disease transmission from bats contaminated materials because of their greater propensity for putting hands in their mouths.

It was observed that, Guano build-up in classroom and offices creates health hazard to both students and staff as bats guano is known to provide a growth medium for microorganisms, some of which are pathogenic, example *Histoplasma capsulatum* which causes a lung disease called Histoplasmosis, a flu-like respiratory disease (Calisher *et al*., 2006). Guano accumulating more frequently under weak or damaged ceilings in some schools also presents a real sanitation problem because in most schools students were expected to clean the nightly faecal deposit as their daily routine activity. This could cause the infectious spores to become airborne when the soil is disturbed and eventually inhaled by school children. Long time accumulation of guano was observed to exert excessive weight on ceilings which has resulted into deterioration of ceilings. According to Kunz and Reynold (2003) such accumulation

suggests long-time use by bats as maternity roosts and roost fidelity. Allowing bats colony to persist for years and guano deposits to accumulate to such an extent is an indication of high level of tolerance to roosting bats by schools management. The tolerance was however, observed in many schools to be a result of neglect and lukewarm attitudes among school management staff on school's property and children's health. The situation is also coupled with the fact that public pre-tertiary schools in the study area are poorly maintained structurally. These kinds of disregard could only result into maintenance issues and eventual unjustifiable killing of bats.

The situation ranges from fear on the side of teachers and school children in particular while the class activities is going on, non conducive classrooms environment as a result of distracting noise produced by bats especially during sunny days, offensive odour that permeates the entire classroom, irritating stained ceiling and scratching sound produced from their hideouts. Roosting bats taking over classrooms and other important school buildings has limited the use of some school resources and has necessitated school authorities to combine students of different classes into one class. These kinds of nuisances by roosting bats in human dwellings might have further augment the perceived negative image held by people toward bats (Fenton, 2003).

5.3 Knowledge and Attitude of School Children in Zaria toward Bats

Although certain questions were answered better than other question, the overall knowledge scores of the school children were specifically low for both bat biology and their ecological roles. While the majority of them were unaware of the biology and ecological roles of bats, nearly all of them (95.1%) were aware that bats can transmit/spread diseases, and more than half (58.5%) disagreed that bats are the only transmitter of Ebola virus. These results might have resulted probably from the

previous intensified awareness campaign on Ebola Virus Disease some months back by various governmental and non-governmental agencies using different media outreach, some of which includes handbills and posters distributed to schools. These posters were still present at the time of this research posted in key places for students to read. Bats were featured mostly as predominant suspect of the Ebola virus disease outbreak and the sole transmitter of such disease. On the other hand, the low scores on general knowledge of bats could be attributed to non availability of authentic sources of information about bats as most of the students primarily relied on family/friends and radio/television as their sources of information about bats, and that bats are unfamiliar to human both behaviourally (Kellert 1993 and Devey, 1994) and morphologically. Features that can appeal to man such as similarity to humans, shape, type of locomotion, posture, surface texture and colour are absent in bats (Mahmood *et al.*, 2011). As regard to gender, girls had higher percentages of incorrect answers than boys, these differences could be as a result of girl's strong acceptance of mystical beliefs, and that girls are less inclined to outdoor activities, which according to Prokop and Tunnicliffe (2008) would result into negativistic attitude toward wild animals. The percentages of correct answers to most of the questions were observed to increase with increasing level of education (class in school). This indicated that, the higher the level of education attain by an individual the more he/she dispel some misconceptions held about bats.

5.4 Differences in Attitudes toward Bats in Relation to Gender and Level of Education among school children in Zaria

Previous studies (Kellert, 1996; Sheeline, 1991 and Bjerke, 1998) have verified that attitudes towards animals differed between set of people marked out by demographic

variables. Attitudes among the genders and level of education of the respondents about bats were also found to differ in this study. Gender is perhaps the most important demographic characteristics affecting attitudes towards animals (Prokop *et al.,* 2009). Males generally like indigenous wild animals, whereas female tend to prefer exotic animals. In this study, girls had higher percentages of agreement to negativistic statements followed by, aesthetic and moralistic and naturalistic statements while boys expressed more support to utilitarian and dominionistic statements. This is rather surprising that, even though girls show more negative attitudes, they were still more concerned on protecting bats from suffering (moralistic attitudes) and tended to express more concern about bats conservation than did boys. This gender difference was consistent with findings of Bjerke and Ostdahl (2004), Prokop and Tunnicliffe (2008), and Mahmood *et al,*. (2011). The responses in each attitude sub-scale decreased with increasing level of education with the exception of utilitarian sub-scale.

The overall analysis of the respondent's responses shows that school children in Zaria hold diverse attitudes toward bats in the sense that they clearly differentiate between several types of attitudes. Negativistic attitude type ranked above all other types, followed by, in descending order, aesthetic, ecoscientistic, moralistic, dominionistic, and utilitarian attitude. The least agreement with dominionistic, utilitarian and naturalistic statements was also found in previous studies for animals among young children where Kellert typology has been used (Eagles and Muffitt, 1990; Bjerke *et al*., 1998 and Kellert, 1996) where children responded against concerns for the material value of animals (utilitarian), against the interests to master or control animals (dominionistic) and not wanted to live where they are (naturalistic). Despite the fact that majority of the students show dislike, fear and regarded bats as nuisance

animals (negativistic), they however considered bats as symbol of natural beauty and liked to see bat pictures (aesthetic attitude), and also wanted to know more about bats and their ecological roles (ecoscientistic interests). This dislike and fear may be attributed to the fact that the respondents were unfamiliar to both behaviour and morphology of bats or lacked genuine sources of information about bats while their ecoscientistic interests could be linked to the curious nature of young children of wanting to know about things within their immediate environment.

5.5 Effect of Education on School Children's Attitudes Change towards Bats

The result of unit presentation on the biology of bats and their conservation to selected students shown in table 20 shows that, students significantly improved their knowledge after attending the lesson presentation. Their attitude also improved positively. This confirmed a strong link between the factual knowledge and positive attitude; the greater the school children's knowledge of bats the more their positive attitudes towards them. This was in line with Kellert and Westervelt (1984) who asserted that, knowledge about animals is considered precursor of attitudes towards them. Mahmood *et al.* (2011) found almost similar result; that, the more the students knew more about biology of bats the more positive attitude they also had. Likewise, research on environmental/wildlife topics has found that the higher a person's actual knowledge the better their attitude (Cohen, 1973; Mangas and Martinez, 1997; Bradley *et al*., 1999; Aipanjiguly *et al*., 2003; Prokop *et al*., 2009). However, Kuhlemeier *et al*. (1999); Makki *et al*. (2003); Lukas and Ross, 2005 and Brossard *et al*. (2005) had a contradictory result that environmental/wildlife education increases knowledge about a topic but this does not always translate into a better attitude (Kuhlemeier *et al*., 1999; Makki *et al*., 2003; Lukas and Ross, 2005; Brossard *et al*., 2005).

The ecoscientistic interest shown by school children in this research might have helped in achieving this significant attitude shift from negative to positive. Their attitude toward bats may not only have actually attributed to the bats related nuisances or damages only but probably to a mixture of lack of knowledge, and the acceptance of culturally-inherited beliefs. The outcome of the lesson presentation indicates that only little effort is required to foster positive attitudes among children toward unfamiliar wild animal.

CHAPTER SIX

6.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary

Overall, this research showed synthesis between basic ecological field survey and human dimensional conservation biology, on issues relating to bats roosting in public pre-tertiary schools in Zaria. The survey of public primary and secondary schools yielded establishment of 21 schools with bat roosts, and were found to experience a number of damages and nuisances. The school children's knowledge and attitudes towards bats varied significantly among gender and level of education (Class in school). Girls lacked knowledge about bats than the boys, and showed more negative attitudes. Response analysis of pre-test and post-test showed that education through classroom lesson presentation to school children about unappealing wild animals (bats) residing in urbanised environs not only increased their knowledge about such animal but also result into change of attitude from negative to positive towards their conservation.

6.2 Conclusion

It is concluded that;

i. Of all the public primary and secondary schools within Zaria metropolis, 21 (28%) had roosting bats at the time they were surveyed.

ii. Colony of roosting bats causes a considerable damage to ceilings and nuisances such as urine stains, noises, guano droppings and smell to the extent of interfering with teaching and learning activities in schools they occupied.

iii. Both the knowledge of, and attitudes toward bats were found to be significantly influenced by gender and level of education (class in school) among school children in Zaria.

iv. There were significant changes in school children's attitudes in favour of bats conservation as a result of knowledge gained. Hence there is a strong link between the factual knowledge of bat and better attitude of school children towards them.

The results obtained are likely to contribute to the local knowledge base of bats in human-dominated areas, their potential nuisance/damages/health risks and children attitudes towards them. The results also indicated the need for collaboration between local conservationists and biology educators in alleviating urban - wildlife conflicts and generate more positive attitude toward little-understood and feared wild animal species in favour of their conservation.

6.3 Recommendations

Based on the findings of this study the following recommendations were made;

a. Simple repairs and maintenance should be carried out regularly in schools with bats damages to restored effective teaching and learning environment.

b. If exclusion of bats from school building is necessary as it was obvious in some schools surveyed, it should be conducted using humane and environmentally sound methods, and be monitored by a qualified biologist to ensure that they are sealed out and not sealed in or persecuted.

c. Environmental education packages such as posters and handbills that contain bat's factual knowledge should be provided to schools that still harbour bats. Such packages should be designed in a more feminine and child-friendly way with rich information on how to humanly handle bat related health risks and nuisances.

d. Teaching methods that promote observation, experimentation and discussion in order to favour ecological understanding should be used by biology teachers.

e. Further surveys should be conducted on the status of roosting bats in other public and private owned buildings so that the future trends of such roosts could be observed and monitored for conservation purposes.

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APPENDIX I

Request for the Validation of Questionnaire

Department of Biological
Sciences,
Faculty of Science,
Ahmadu Bello University, Zaria.
17TH October, 2014.

Prof. Usman A. I.
Institute of Education,
Department of Science and Technical Education,
Ahmadu Bello University, Zaria

Dear Sir,

REQUEST FOR VALIDATING A RESEARCH INSTRUMENT

I adapted a questionnaire and I have made slight modifications to generate data for some aspects of my M.Sc thesis titled "Survey of Bat Roosts in Public Pre-Tertiary Educational Institutions and the Attitudes of Students towards Bat in Zaria, Nigeria". The target population are primary and secondary school students (Primary 5 - 6 and JSS I - SSS III). Attached herewith are the questionnaire and the brief description of what each question is meant to measure.

I would like you to please examine the items in respect to the following.

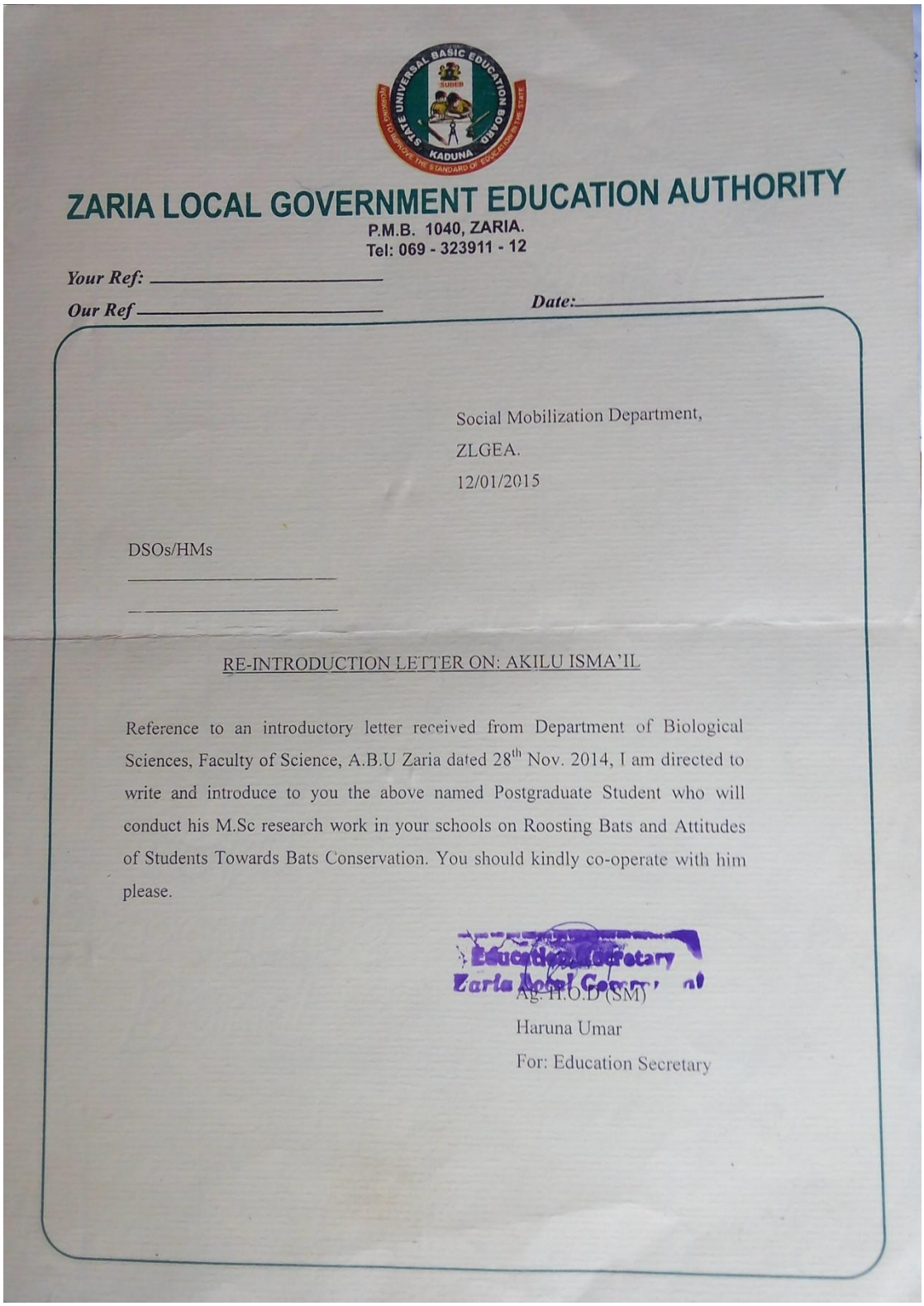
i. Do the items relate to cognitive level of the target population?
ii. Are the items readable, appropriate, of standard and shortly expressed?
iii What general criticisms and suggestions can you give for the improvement of the instrument?

I very much thank you and appreciate your assistance please.

Yours truly
Akilu Isma'il

APPENDIX II

Introduction letter from Zaria Local Government Education Authority



ZARIA LOCAL GOVERNMENT EDUCATION AUTHORITY

P.M.B. 1040, ZARIA.
Tel: 069 - 323911 - 12

Your Ref: _____

Our Ref _____ *Date:* _____

Social Mobilization Department,
ZLGEA.
12/01/2015

DSOs/HMs
_____
_____

RE-INTRODUCTION LETTER ON: AKILU ISMA'IL

Reference to an introductory letter received from Department of Biological Sciences, Faculty of Science, A.B.U Zaria dated 28th Nov. 2014, I am directed to write and introduce to you the above named Postgraduate Student who will conduct his M.Sc research work in your schools on Roosting Bats and Attitudes of Students Towards Bats Conservation. You should kindly co-operate with him please.

Education Secretary
Zaria Local Govt. Area

Ag. H.O.D (SM)
Haruna Umar
For: Education Secretary

APPENDIX III

List of Schools Surveyed for Bat Roosts in Zaria Metropolis

S/No	List of primary schools in zaria where the research was carried out
1	A.M.B Lawal Sambo LGEA Kofar Kona
2	A.M.B Sule Buba LGEA
3	Abdulkarim LGEAPrimary School Rimin Tsiwa
4	Abdurrahman Mora LGEA
5	Abdussalam LGEA Anguwan Bishir
6	Abubakar Imam LGEA
7	Abubakar Maccido LGEA
8	Adamu Dikko LGEA Gaskiya
9	Ahmadu Fatika LGEA Anguwan Fatika
10	Ahmadu Gyallesu LGEA
11	Aliyu Liman kona LGEA Limanci Kona
12	Aliyu Magajin Mallam LGEA Banzazzau
13	Alkali Gambo LGEA Anguwan Alkali
14	Alu Dansidi LGEA
15	Baba Ahmed Model Tudun Wada
16	Bashir Abubakar LGEA Anguwan Dankali
17	Bello Aliyu LGEA
18	Dahiru Kanti LGEA Rimin Danza
19	Dallatu Samaila Kofar Jatau
20	Dan Madami LGEA
21	Daniel Gowon LGEA Wusasa
22	Dr. Aminu L. Sherehu LGEA pan-wanki
23	Dr. Muhammad Jumare LGEA Jushi
24	Dr. Nuhu Bayero LGEA Kaura
25	Dr. Shehu Idris LGEA Babban Dodo
26	Galadima Adamu LGEA Kofan Galadima
27	Haruna Soba LGEA Dakace

28 Justice Bashir Sambo LGEA Lemu

29 Lawal A. M Malam LGEA Banzazzau

30 Liman Kwaire LGEA Alfadarai

31 Lt. Col. M. M. Jumare LGEA Kofan Gayan

32 Nuhu Bamalli LGEA Kwarbai

33 Nuhu Baturen Makaranta LGEA Anguwan Kawu

34 Sarki Ja'afaru Mazan Gudu

35 Sarki Musa LGEA Kwarbai

36 Sarki Sambo LGEA Science Primary School Pada

37 Tsoho Abdullahi LGEA

38 Turaki Aliyu LGEA Magajiya

39 U.B.A Kusfa

40 U.B.E Gwargwaje Police Barrack

41 U.B.E Isan Nabawa

42 U.B.E Kauran Juli

43 U.B.E Kofar Kibo LGEA

44 U.B.E Nagoyi

45 U.B.E Prof. Idris Abdulkadir, Karofi

46 U.B.E Unguwan Kaya

47 Waziri Lawal LGEA Kofan Kuyambana

48 Yahaya Hamza LGEA

49 Yamusa LGEA Rimin Doko

50 Zage-Zagi LGEA

51 Zubairu Isah Raka LGEA Salmanduna

Source: Zaria Local Government Education Authority, Zaria (2014).

S/No	List of secondary schools in zaria where the research was carried out
1	Alhuhuda College Zaria
2	Barewa College Zaria
3	Commercial College Zaria
4	GGSS (WTC) Zaria
5	GGSS Dogon Bauchi
6	GGSS Kofan Gayan
7	GGSS Pada
8	GGSS T/Wada
9	GJSS Gyallesu
10	GJSS Rimin Doko
11	GSS Aminu
12	GSS Chikaji
13	GSS Chindit Barrack
14	GSS Dakace
15	GSS Kofan Doka
16	GSS Kofan Jatau
17	GSS Kofan Kuyamba
18	GSS Magajiya
19	GSS Muchia
20	GSS T/Jukun
21	GSS T/Wada
22	GSS Zaria
23	GSSS Kaura
24	Science School kufena

Source: Kaduna State Ministry of Education, Zaria Inspectorate Division (2014).

APPENDIX IV

Krejcie and Morgan (1970) Table for Determining Sample Size from a Given Population

N	*S*	*N*	*S*	*N*	*S*
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Note.—*N* is population size.
S is sample size.

APPENDIX V:

QUESTIONNAIRE

DEPARTMENT OF BIOLOGICAL SCIENCES,
FACULTY OF SCIENCE, AHMADU BELLO UNIVERSITY, ZARIA

Dear Students,

I am a student of Ahmadu Bello University, Zaria. This is a postgraduate research on the topic: Survey of Bat Roosts in Pre-tertiary Educational Institutions and the Attitudes of Students towards Bats Conservation in Zaria. Kindly fill the Questionnaire as honestly as you can. Any information you give will be treated with confidentiality and used for the purpose of this research work only.

Thank you for your cooperation.

Kindly tick the correct options or fill in the spaces where necessary.

SECTION A: DEMOGRAPHIC INFORMATION

Your School's Name …… Class Register Number…….

1. Which Class are you? Primary 5 – 6 ( ) JSS I – III ( ) SSS I – III ( )

2. What is your age? Below 12 ( ) 12 - 14 ( ) 15 - 17 ( ) 18 and above ( )

3. Are you male or female? Male: ( ) Female: ( )

SECTION B: KNOWLEDGE ABOUT BATS**

How much do you know about bats? Nothing ( ) Very little ( ) Some ( ) A fair amount ( ) A great deal ( )

Which of these statements do you think are true or false?	**TRUE**	**FALSE**	**I DON'T KNOW**
1. Bats are birds	( )	( )	( )
2. Bats have more than 2 babies each year	( )	( )	( )
3. Bats can live up to 5 years and above	( )	( )	( )
4. Bats are mammals	( )	( )	( )
5. Bats are blind	( )	( )	( )
6. Some bats eat only insects	( )	( )	( )
7. Some bats help to spread seeds from trees	( )	( )	( )
8. Bats live in trees and buildings only	( )	( )	( )
9. Bats are examples of Wild animals	( )	( )	( )
10. Bats are good for the environment	( )	( )	( )
11. Bats can spread diseases	( )	( )	( )
12. Bats attack people	( )	( )	( )
13. Bats are the only transmitter of Ebola virus	( )	( )	( )

SECTION C: MYTHS AND CULTURAL BELIEFS ABOUT BATS

Which of these statements do you think are true or false?	TRUE	FALSE	I DON'T KNOW
1. Bats bring bad luck	( )	( )	( )
2. Bats are cursed by God	( )	( )	( )
3. Bats are likeable animals	( )	( )	( )
4. Bats suck blood from human beings	( )	( )	( )
5. Bats are dirty and bad	( )	( )	( )
6. Bats are symbols of witchcraft	( )	( )	( )
7. Bats are useless animals	( )	( )	( )
8. Bats are animals of mis			

SECTION D: ATTITUDES TOWARDS BATS**

How much do you agree or disagree with each of these statements?

Questions	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1. Bats are good for some trees (P)					
2. I do not like having bats in the trees/buildings where I live(N)					
3. I would prefer to live in a town with bats (P)					
4. Bats should not be allowed to fly where they Want (N)					
5. I would like to know how bats are useful to human beings (P)					
6. Children need to learn more about bats in school (P)					
7. Bats are a symbol of natural beauty (P)					
8. Bats are nuisance animals on the earth (N)					
9. Watching bats fly around at sunset is Beautiful (P)					
10. I can live in places where there are lots of bats (P)					
11. Bat are ugly animals (N)					
12. Bats should not be allowed to eat whatever they wish (N)					
13. Bats were here before us and should be treated with respect (P)					
14. If I see a bat I feel tense (N)					
15. Bats deserve protection (P)					
16. Bats are one of God's creatures and should be protected (P)					
17. Bats should be used to encourage tourists to come to Zaria **(P)**					
18. I would like to know more about what bats eat (P)					
19. The number of bats should be controlled by people (N)					
20. Where bats live should be controlled by people (N)					
21. Bats have the same right to live as people (P)					
22. Bat's faeces should be used as manure in our farms **(P)**					
23. I like pictures of bats (P)					

SECTION E: SOURCE OF INFORMATION ABOUT BATS

Where do you get your information about bats? [TICK ALL THAT APPLY]

Friends and Family ( ) School teacher ( ) Newspapers/Magazine ( )

Radio/Television ( ) Library/books ( ) Internet ( ) others ( )

SECTION F: RISKS AND PERCEIVED RISKS OF HAVING CONTACT WITH BATS

Which of these statements do you think are true or false?	**TRUE**	**FALSE**	**I DON'T KNOW**
1. I have killed a bat before	( )	( )	( )
2. I have seen a grounded bat before	( )	( )	( )
3. I have touched a bat before	( )	( )	( )
4. I have been scratched/bitten by bat before	( )	( )	( )
5. I can be bitten by a bat without knowing it	( )	( )	( )
6. There is no way I can be bitten by a bat	( )	( )	( )
There is likelihood of a bat to land on me	( )	( )	(

Thank you for participating

KEYS:

** Indicated the sections that were re-administered as post-test to randomly selected student

P = Positively stated

N = Negatively stated

Items in Section D	**Attitude Sub-measure**
1, 17 and 22	Utilitarian
2, 8 and 11	Negativistic
3 and 10	Naturalistic
3, 12, 19 and 20	Dominionistic
5, 6 and 18	Ecoscientistic
7, 9 and 23	Aesthetic
13, 15, 16 and 21	Moralistic

APPENDIX VI

Lesson Plan on the Educational Unit on Bats

Class: Primary 5 - 6; JSS I –III; SSS I – III

Number of Students: 30

Duration: 1 class period (45 minutes)

Subject: Basic Science (for upper primary and Junior Secondary Class);

Biology (Senior Secondary School)

Topic: Bats

Specific objectives: By the end of the lesson, students should be able to;

i. Explain the basic biological characteristics of bat.
ii. Mention some of the ecological roles played by bats.
iii. Identify the need for bat conservation.
iv. Correct the misconception they hold about bats.

Instructional resources: Chalk, Chalkboard, cardboard paper containing diagrams of important concepts, Copies pamphlet containing the unit to be presented

Previous knowledge: Students have some sort of ideas about bats.

Presentation:

Step I (7 min): Introduction: The teacher introduces the lesson by asking the following questions:

i. What are bats?
ii. Do you think bats are of importance to us?
iii. If yes, in what ways are they important?

Step II (2 min): The teacher distributes the learning material (pamphlets) to students

Step III (10 min): Biology of Bats: The teacher explains to the students

- What bats actually are
- Bat Habitat
- Bat Foods

Step IV (10 min): Using teaching aid, the teacher explains;

- Bats physical features
- Ecological roles of bats

Step V (10 min): Bat conservation: The teacher explains

- Reasons for bat conservation
- Ways of saving bats from harm

Conclusion (6 min): The teacher concludes the lesson by going through the main points inside the pamphlet distributed with students, and salient points are also highlighted.

Evaluations: Questionnaires were distributed to the students to fill and return.

APPENDIX VII

Educational Pamphlet on Bats (Introductory)
(Designed for Upper Primary (5 – 6 Class) and Secondary School Students)

BATS

What are Bats?

Bats are a group of mammals that are very specialized for their unique life styles. Contrary to popular misconceptions, bats are not rodents with wings or birds. The scientific name for the group is "Chiroptera" which in Greek means hand-wing. All living bat species fit into one of two sub-groups, the Microchiroptera or the Megachiroptera. Bats are the only mammals capable of true flight.

Bats as a Mammal

Characteristics that makes bats mammals are;

- They have fur or hair on their body
- A baby bat is born live
- The babies nurse from their mom
- Bats have arms, hands and feet
- They are warm blooded.

Population and Range

As a group, bats are very diverse. There are more than 1,000 different kinds (species) of bats in the world. In fact, 1 out of every 4 mammal species is a species of bat. While some bat populations number in the millions, others are dangerously low or in decline. Bats can be found almost anywhere in the world except the Polar Regions and extreme deserts.

Bat Habitat

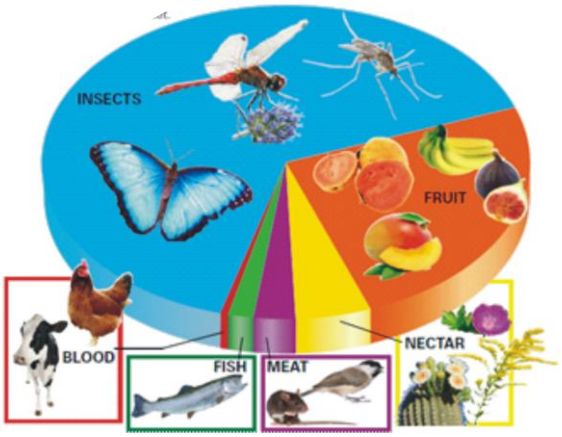
Many bats find trees to be the perfect place to live and spend time taking care of their babies. Some bats actually live under big leaves and by using camouflage they can hide from harm and danger. There are other bats that live in caves or old mines. At times bats may live in houses or buildings, even though these places are not as good as their natural habitats, they do offer them protection.

Page 1

Bat Foods

Throughout the world, The nearly 1,000 different kinds of bats feed on an amazing variety of foods including fruit, pollen, nectar, frogs, fish, small mammals, blood and of course, insects, and sometimes, while doing so, help humans. Different diets are;

- **Fruit-Eating Bat (**Frugivore): they eat fruit such as mango. As they fly they drop seeds which can grow into new trees.
- **Nectar-Eating Bats (**Nectarivore): Some bats that like to eat up pollen. By going from flower to flower, bats help make new plants.
- **Insect-Eating Bats (**Insectivore): They use vision, echolocation and sounds from their prey to help locate their food.
- **Meat-Eating Bat (**Carnivore): They grab and eat little fish out of the water with their claws. Some eat mouse or frog. Echolocation is used to find this food.
- **Blood-Eating Bat (**Sanguivore): Also known as vampire bats, they drink the blood of birds. One kind of vampire bat also drinks the blood of other mammals like cattle.



Pie chart showing the proportion of bat species with each kind of bat diet

Page2

Bat's Body

Bat's body does many things that help it live. Their body part includes;

Ears: Bats have very good hearing. They use it for finding food and locating their babies. For insect and fish eaters, the big ears help with echolocation.

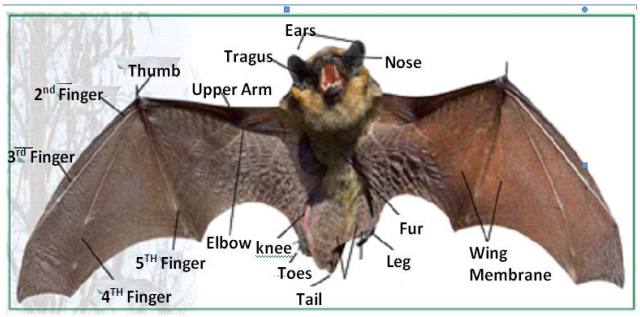
Eyes: Bats are not blind! Bats' eyes are better at seeing in the dark. Most see objects only in black and white, but color vision is known to exist in some fruit bats.

Nose: The sense of smell is well developed in most bats. It is used to find and identify certain foods and to recognize roost mates and young. Fruit eating bats can find their food by the smell of the ripening fruit. Nectar seeking bats gather pollen on their snout, and by going from flower to flower help create new plants.

Feet: With their strong claws, bats are able to hang upside down in their roosts. Fishing bats also use their claws to scoop up the fish they will eat.

Hands and Wings: Bats fly by using their hands and wings. While the wings are flapping, bats can go up or down by moving the membrane between the body and fifth finger. This is called "lift." Bats move forward (called "thrust") by changing the shape of the membrane between the second and fifth fingers.

Hair on their Body: The hair protects the bat because different colors and designs can serve as camouflage and they can hide from danger. The fur is kept clean by regular licking, somewhat like what a cat does. In the coldness it helps keep the bat warm.



Different body parts of a bat

Lifespan

Although they reproduce slowly, bats are long-lived. They can sometimes live up to 30 years.

Bat's Reproduction

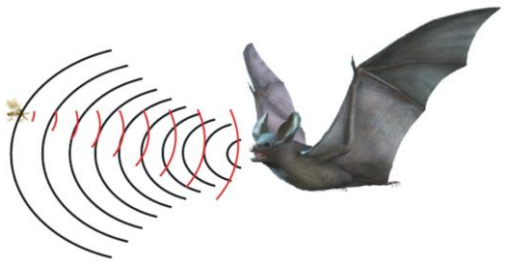
Unlike rats, which may produce many young each year, most bats produce only one or two young, known as a "pup," each summer. The young are born blind and hairless. The females nurture their young which grow rapidly. Most young bats start to fly by the time they are one month old. Bats are the slowest reproducing mammals on Earth.

Overwintering

To survive the cold weather some species of bat migrate, others hibernate, and yet others go into torpor.

ECHOLOCATION

Bats send out sound using their mouth or nose. When the sound hits an object an echo comes back. The bat can identify an object by the sound of the echo. They can even tell the size, shape and texture of a tiny insect from its echo. Most bats use echolocation to navigate in the dark and find food. Using sound alone, bats can "see" everything but color, and in total darkness they can detect obstacles as fine as a human hair.



A picture of a bat emiting a high-freuency sound, which hit an object and bounces back to the bat, telling it how far the object (prey) is.

ECOLOGICAL ROLE OF BATS

Bats play a vital role in the health of our natural world. They are known throughout the world to

- **Feeds on Insects**: Some bats help control the insect population such mosquitoes, beetle etc., with bats eating all those insects, this means fewer chemicals and poisons will be used on crops, and that's healthier for all of us! This saves crops from damage, and makes more food available at the market.

- **Plants Pollination and Seed Dispersal:** Some bats pollinate plants that provide food for humans by going from flower to flower thereby create new plants. As they eat up fruits they also help in forest regeneration.

A picture of a Nectar-Eating Bat (Nectarivore) trying to eat up pollen.

- Bacteria in their guano are useful in improving soaps, making gasohol and producing antibiotics.
- Bats guano can use as fertilizer on agricultural crops due to its high concentrations of nutrients like nitrogen and phosphorous.
- Some bats act as predators while some are prey to certain animals.

Bats Roles in Disease Transmission

It is true that bat harbours quite a number of pathogenic microorganisms and they are capable transmitting

them to human. But, the important point here is that unlike other wild animals bat are very peaceful animals that bite only on self defense. So, if you do not handle them or go near them they can never bite you.

BATS CONSERVATION

Threats to Bats

The greatest threat to bats is people. Habitat destruction and fear are a fatal combination for bats. In some areas, people have even been known to set fires in caves, killing thousands of roosting bats. Bats are also killed by development projects such as renovation or demolition of places they occupied.

Reasons for Bats Conservation

We are in danger of losing many colonies of bats because people have a lot of wrong ideas about them. Since many people don't know the truth about bats, they are afraid of them. Sometimes, when people are afraid of something, they want to get rid of it. And that is what is happening to bats around the world. Uninformed people want to get rid of bats. But we can save the bats from this harm!

Ways of saving bats from harm

1. Do what you are doing now (i.e. learn more about bats).
2. Tell your family and friends what you know about bats so they will respect them too.
3. Do not disturb bats where they live. Stay out of their homes. Don't go into caves where they live, or under bridges where they are, or in buildings where you might find bats. Leave them alone!
4. Visit your library often and check out the different books on bats. Invite your friends to go with you and read together