ASSESSMENT OF VERTEBRATE DIVERSITY IN ALABATA NATURE RESERVE ABEOKUTA, SOUTH-WEST NIGERIA

BY

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ABSTRACT

The importance of wildlife, especially the vertebrates for game, tourism and medicinal use cannot be over emphasized. Nature reserves are also known to influence the ecosystem of its location. However, rapid increase in land use for agriculture and other physical developments are gradually reducing wildlife habitation including the Alabata area nature reserve of Abeokuta. Inventory of these resources in relation to their habitat parameters would inform their better management. Assessments of vertebrate and associated flora diversities were therefore carried out in Alabata Nature Reserve.

The study covered 20 km^2 out of 97.3 km^2 area of Alabata Nature Reserve. Twenty sample plots each of 25m x 25m were laid randomly. Animals, vegetations, soil and level of human interference were assessed for 24 months in each plot cutting across wet and dry seasons. Animals were surveyed weekly using the King Census and Line Transect methods, by direct and indirect modes. Vegetation was surveyed using the Point Center Quarter method. Soil samples were collected randomly with auger at 0-15cm, 15-30cm and 30-45cm depth; air-dried and analysed for pH, Organic Carbon (OC), nitrogen and Particle Size (PS) distribution using standard methods. Structured questionnaires were randomly administered to 20 residents in the farm settlements adjoining the study site to assess the level of human interference. Data were analyzed using descriptive statistics, Dominance, Shannon Weiner, principal component as well as Simpson, Evenness and Equitability indices.

Forty species of wild vertebrate belonging to thirty-one families were encountered at the study site. *Thryonomys swinderianus* was the most abundant vertebrate species with a mean frequency of 319±40.8, followed by *Xerus erythropus* (143±2.9) and *Arvicanthus niloticus* (122±15.3) while *Ploceus capensis* (5±3.9) was the least abundant. *Daniellia oliveri* (1123±4.6) was the most abundant tree species, followed by *Anona senegalensis* (270±3.9) and *Bridelia micrantha* (179±3.5). Mean soil pH value was 5.4±0.2 and 6.6±0.3 during the wet and dry seasons respectively. The OC of the soil ranged from 13.2% to 66.8%, while nitrogen content was from 0.8% to 7.5% and mean PS was from 3.2±0.2 to 90.4±4.5. Hunting intensity was perceived to be low (20.0%), although burning due to stray fire was perceived to be high (46.0%) in the site. The animal species diversity indices were Shannon Weiner (0.6), Simpson Index (0.9), Evenness (0.4), Dominance (0.004) and Equitability (0.9) for the wet season. and Shannon Weiner (0.6), Simpson Index (0.9), Evenness (0.4), Dominance (0.005) and Equitability (0.9) for the dry season.The plant species diversity indices were Shannon Weiner (0.6), Simpson Index (0.9), Evenness (0.5), Dominance (0.005) and Equitability (0.9) for wet season and Shannon Weiner (0.6), Simpson Index (0.9), Evenness (0.6), Dominance (0.9) and Equitability (0.9) for dry season. The principal component analysis and ordination showed that the studied ecosystem was not stable.

Diversity of vertebrate species in Alabata Nature Reserve was high. Abundace of *Thryonomys swinderianus* and *Xerus erythropus* can be attributed to adequate food and cover provided by trees. However, wildfire which is the greatest threat has to be controlled for the reserve to realize its full potentials.

Keywords: Wild vertebrate diversity, Alabata Nature Reserve, Wildfire, Wildlife habitat

Word Count: 497

CERTIFICATION

I certify that this work was carried out by Mr. Shotuyo, Abdul Lateef Aderemi in the Department of Wildlife and Fisheries Management, University of Ibadan, Ibadan

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DEDICATION

This work is dedicated to Almighty Allah, The Beneficent, The Merciful, for His support during the course of this work.

And to the memory of my parents Mr. D. O. Shotuyo and Mrs. W. T. Shotuyo for all their labour, may their souls rest in peace.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

The moist tropical forest of Central and West Africa, with the multitude of plants and animal species found within them, are one of the world's greatest biological treasures, and represents one of the most valuable assets for many countries in equatorial Africa. Rain forests are valuable because they serve so many life-sustaining functions. They provide food such as fruits, nuts and meat to people who live near them. They provide building materials and medicines for local uses, as well as timber for export. Intact rain forests stabilize soils, reducing erosion and hence providing clean water to drink, and play a key role in the regulation of climate, both locally and globally. The beauty, diversity and rarity of rain forest species attract tourists and scientists from all over the world, as well as inspiring unique and lasting cultural traditions among the people of the forested African countries.

The African rain forest still covers a vast area, stretching from Guinea in the west across to the coast of East Africa, but it faces a wide range of threats. The rain forests of east and West Africa have already been reduced by human activities in the last century or so, and today little forest vegetation survives outside protected forest reserves, wildlife sanctuaries and national Parks. The central African forest block remains largely intact, but even the most remote areas are likely to be affected in the near future by combined forces of deforestation and exploitation. As human population increases steadily, and more and more land is needed for agriculture, and as technology advances, exploitation for timber, meat and other forest products becomes more intensive and damaging.

Under this scenario protected areas and their management staff have a crucial role to play if biological diversity is to be conserved. However, just as there are a wide variety of habitats and vegetation types within the forest, protected areas are designed to fulfill many different roles and face a wide variety of threats. Many protected areas have been established throughout forested Africa, with reserve boundaries, hunting restrictions and certain management goals, among other things, certainly described in legal documents. However, these protected areas do not function as they intended to protect the natural resources contained within them.

The Nigerian rain forest zone occurs between latitude $4^{o}51^{!}$ And 7^{o}N and longitudes 3o 30! And 3o 37!E. It covers an area of about 95,560Km which represents about 10% of the Nigerian land area.

The vegetational structure of the Nigerian rainforest region is being altered at a fast rate, transforming to vegetational types such as derived savannah in most of Oyo, Ogun and Anambra states, and also to dry semi-deciduous rainforest types in parts of Oyo, Ondo and Ogun States. The trend in the rapid depletion of the natural rainforest has been due to population pressure, slow growth rate in agriculture production and sufficiency and threat to rural livelihood income security. At the same time human pressure on land is eating at the delicate environmental equilibrium that has evolved over centuries. Forest cover is shrinking and biodiversity is getting lower. The threat therefore, to the remaining pockets of rainforest becomes greater (IITA, 1996). It has been observed that the future of the Nigerian rainforest is bleak and the whole of Nigerian rainforest may disappear in this century if this trend is allowed to continue. Certainly this millennium is headed for a surprise.

Biodiversity is the total richness of biological variation. Usually the scope of biodiversity is considered to range from the genetic variation of individual organisms within and among populations of a species to different species occurring together in ecological communities. Some definitions of biodiversity also include the spatial patterns and temporal dynamics of populations and communities on the landscape. The geographical scales at which biodiversity can be considered ranged from local to regional, state or provincial, national, continental, and ultimately to global. (Ayodele and Lameed, 1999).

Biodiversity at all scales is severely threatened by human activities, making it one of the most important aspects of the global environmental crisis. Humans have already caused permanent losses of biodiversity through the extinction of many species and the loss of distinctive, natural communities. Ecologist predict that unless there are substantial changes in the way human affect ecosystems, there will be much larger losses of biodiversity in the near future.(Dawson et.al 2011)

Human activities such as overgrazing, deforestation, bush fires, mining, urbanization and cultivation are the principle causes of habitat destruction. These activities are expanding in line with human population growth and poverty increase. Maintaining the high quality habitats and ensuring the long-term ecological integrity is therefore increasingly becoming an important management challenge. Establishment of wildlife PAs has been adopted as the most feasible strategy to this end. Currently some 104,791 PAs covering a total area of about 20 million km2 or 12.7% of the earth's surface have been created. This is a dramatic increase compared to only 8,500 PAs covering some 7.7 km2 (equivalent to 5.2% of the earth's sur face) existed in the last decade (IUCN1990).

In Africa loss of wildlife habitats is a widespread phenomenon. The current loss is estimated at 60%. Human population pressure is cited as the main contributor to this loss, mainly through deforestation prompted by increased demand for arable land, settlements and fuelwood. The majority of sub-Saharan Africa's population is dependent on fuelwood: 82% of all Nigerians, 70% -Kenyans, 80% -Malagasies, 74% Ghanaians, 93 - Ethiopians, 90% - Somalians and 81% - Sudanese.

Biodiversity can be protected in ecological reserves. These are protected areas established for the conservation of natural values, usually the known habitat of endangered species, threatened ecosystem, or representative examples of widespread communities. The World Conservation Union, World Resources Institute, and United Nations Environment Program are three important agencies whose mandates center on the conservation of world's biodiversity.

Human activities especially agriculture have a significant implication for wild species of flora and fauna. Species capable of adapting to the agricultural landscape may be limited directly by the disturbance regimes of grazing, planting and harvesting, and directly by the abundance of plants and insect foods available. Some management techniques, such as drainage, create such fundamental habitat changes that there are significant shifts in species composition (McLanghlin and Mineau 1995).

1.2 Statement of Problem

Rapid development in form of physical structures and several farms are gradually reducing habitats for wildlife in the Alabata Area of Abeokuta. Human activities such as overgrazing, deforestation, bush fires, mining, urbanization and cultivation are the principle causes of habitat destruction. These activities are expanding in line with human population growth in the Alabata Area. Maintaining the high quality habitats and ensuring the long-term ecological integrity is therefore increasingly becoming an important management challenge. Biodiversity at all scales is severely threatened by human activities, making it one of the most important aspects of the global environmental crisis. Human activities especially agriculture have a significant implication for wild species of flora and fauna. Humans have already caused permanent losses of biodiversity through the extinction of many species and the loss of distinctive, natural communities. It is thus expedient to create a corridor for wildlife to thrive undisturbed, hence establishment of the Alabata Nature Reserve. Fauna species loss is imminent when human activities are uncontrolled in natural ecosystems. The management of these resources therefore requires a comprehensive inventory; hence the assessment of Alabata Nature Reserve.

1.3 Justification

Rapid development in form of physical structures and several farms are gradually reducing habitats for wildlife in the Alabata Area of Abeokuta. Fauna species loss is imminent when human activities are uncontrolled in natural ecosystems.

Biodiversity can be protected in strict nature reserve, ecological reserves, etc. These are protected areas established for the conservation of natural values, usually the known habitat of endangered species, threatened ecosystem, or representative examples of widespread communities.

No comprehensive scientific information is yet available on the biodiversity of the University of Agriculture, Abeokuta almost ten thousand (10,000) hectares of land. It has become almost increasingly difficult to utilize in a sustainable manner any one particular resource in the absence of a comprehensive inventory of the natural resources for a holistic sustainable planning, utilization and management. The need for an appropriate management strategy becomes expedient.

1.4 Objectives

1. Evaluate the flora and fauna species diversity in the Nature Reserve
2. Determine the species status present in the Nature Reserve
3. Evaluate the soil status of the Nature Reserve
4. Assess the impact of human activities on the Nature Reserve

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 BIODIVERSITY CONCEPT AND ASSESSMENTS

In the past one decade, the complex problems surrounding biological diversity or biodiversity arise when it was recognised that there were many more species on earth that scientist had yet described, and that the rate of extinction of species far exceeds the rate of their preservation. The need to conserve them as a foundation for sustainable development becomes very important. As the worldwide loss of biodiversity has been accelerated in recent decades, awareness has grown of the potentially disastrous consequences of this trend for the earth's ecological functions and fulfillment of basic human development needs. (Pereira *et al* 2010).

In the developing countries, particularly in Africa, biodiversity is a matter of survival. The livelihoods of great majority depend on free and open access to great variety of biological resources for food, fuel, medicines, housing materials and economic security BSP, 1993). Based on all these, protection of biodiversity becomes necessary for the maintenance of the biological resource base. Likewise, in Nigeria the rising concern for biodiversity conservation and protection stems from our dependence on the biological resources and rapid reduction in biodiversity of few pristine and natural areas, which remain. (Perrigs *et al*, 2011)

Biological diversity is a broad scientific issue, involving aspects of species richness, species composition, habitat structure, landscape pattern, ecological process, and biological conservation. The convention on biological diversity which came into force at the end of 1993 defined: Biodiversity as 'The variability among living organism from all sources including terrestrial, marine and other aquatic ecosystems and ecological complexes of which they are part. This includes diversity within species, between species and ecosystems (UNEP, 1992, Wikipedia, 2009). McNeely *et al*., (1990) sees biodiversity as an umbrella term for the degree of nature's variety. It encompasses all species of plants, animals and microorganisms, the ecological processes of which they are part.

The simplest definition of biodiversity is the number of species found in an area called species richness,(Dolev and Carmel,2009). For practical reasons, one has to confine the count to those species with which one is familiar, leaving out all the others because many taxa are still unknown, even taxonomically, let alone ecologically (Hengeveld, 1996). For this and other reasons, species richness is still commonly used in the context or biological conservation.

Biodiversity is usually recognised as the concept of three distinct levels namely: (a) Genetic diversity; (b) Species diversity; and (c) Ecosystem diversity (UNCBD, 1992, Ayodele and Lameed 1999). To consider all the ramifications of biodiversity at the genetic, species and ecosystem levels in a landscape is not a simple task. As a result, species diversity is usually viewed the key when evaluating biodiversity.

Species – based approach entail the review of taxa with the aim of identifying species considered to be high priority for conservation. Species diversity is the variety of different species found in an area. In this case, the number is often used as a measure. In some cases taxonomic diversity is used, as it considers the relationships of species to each other. Genetic diversity is the variety of genes within species i.e. biochemical units of hereditary information passed on by parents that determine the physical and biochemical characteristics of their offspring. This form of diversity, according to McNeely *et al.,* (1990) can be between populations of the same species or within distinct populations. Ecosystem diversity can be at the national or sub-national levels. It can also be referred to as the diversity of habitats and processes occurring within the ecosystem. However, ecosystems are not closed systems. It is difficult to define them, but the assessment of biodiversity at this level is certainly very important especially in determining priorities for conservation. (Hawksworth *et al*, 2011).

However, it is perfectly feasible to maintain species independent of the ecosystems or habitats in which they normally occur. At whatever level the problem is looked at, it is axiomatic that the maintenance of species diversity and in particular the prevention of species extinction is pivotal to the conservation of biodiversity.

Biodiversity can be quantitatively expressed from different perspectives depending on the aspects (or functions) of biodiversity under study. On the spatial and temporal scales, numerous proposals for measuring biodiversity is in itself proof of the complexity of the problem and of the difficulties in designing strategies that can be carried out in some reasonable amount of time and with sensible investment in resources (Hawksworth, 1995 and 2007). Since diversity is the variety of living systems, at a number of different levels of resolution, it will be difficult to summarize using one measure.

The concept of diversity which takes species abundance into account is also known as within habitat diversity (Alpha diversity) (Linsenmair, 1997) while Beta diversity is a measure of the replacement of habitats. As such, it corresponds to the spatial contiguity of different communities or habitats (Cody, 1993). Although, beta diversity differs from alpha diversity, it does not add a new type of variation, its difference depending on the spatial scale initially chosen.

Finally, Gamma diversity is understood to mean the diversity of a large area. Linsemair, 1997 also defines Gamma or total diversity of a landscape or geographic area, as a product of alpha diversity of its communities and the degree of beta differentiation among them. Also, in working with species, that is with the "original diversity." Haper and Hawksworth (1995 and 2007) focus on the approaching complex problem of measuring biodiversity which depends on the location of the study area on two scales: (1) That is structured in terms of space and (2) the other in terms of time. So, studies carried out from an ecological perspective are done within limited areas.

2.1.1 Values of Biodiversity

A variety of reasons have been advanced for valuing biodiversity. BSP (1993) noted that people value biological resources in different ways: spiritually, economically, aesthetically, culturally, and scientifically. Biodiversity values also differ at the local, national and international levels. Boyd (1992) noted that biological diversity is perceived from many angles ethical and religious, aesthetic and emotive, economic, utilitarian, legal and mandatory, scientific and technological.

Biodiversity values can be categorized as: (1) human utilitarian; (2) ecological utilitarian; (3) human non-consumptive and (4) ethical or intrinsic. On the whole, it has been suggested that biodiversity could be valued for the sake of its own existence since all creations have a right to exist (Naess, 1986; Norton, 1987; McNeely *et al.*, 1990). We share the earth with at least five million other species all of which have a right to survival.

Unfortunately, biodiversity is under threat due to the extinction of species which is now taking place at an unprecedented rate, possibly 100 times greater than the background or natural rate and these losses are almost all human induced. It is desirable that we find ways to live in greater harmony with nature because the consequences of failing to take action will be unpleasant. Therefore, it has to be valued because its conservation would leave options open for use in future.

IUCN (1990) also reported that more than anywhere else on earth, human well-being in Africa depends on the continued productivity of biological resources. Africa rely on access to these resources to meet their daily subsistence needs, to generate employment and cash, and in many cases to form the basis of their natural economics, and as Africa is, and will continue to be, dependent on its biological resources for food, shelter, and income. Africa needs, therefore; to maintain its healthy productive ecosystems to meet the challenges of coming decades.

Likewise, Nigeria's predominantly rural populations live in over 100,000 villages and hamlets (FEPA, 1992). The majority of the rural populations depend on wild sources of protein supply including fish, snails, rodents, insects and available resources at their disposal with little or no regard for perpetuity. These resources cater for the shelter, food and domesticated livestock for the rural populace (FEPA, 1992). The Gulf of Guinea coastal zone is the economic and political nerve centre of the countries within this zone. For instance, oil found within the coastal zone in Nigeria forms the backbone of the Nigerian economy and almost of its fishery resources found within the coastal zone. In addition the coastal zone is also the food basket of the sub-region (Awosika and Ibe, 1998).

Forests world-wide generate a wide range of goods and services that benefit humankind. From an economic perspective these values can be conveniently classified as:

(a) Direct use values: values arising from consumptive and non-consumptive uses of the forest, e.g. timber, fuel, bush meat, food and medicinal plants, extraction of genetic material and tourism.

(b) Indirect use values: values arising from various forest services such as protection of watersheds and the storage of carbon.

(c) Option values: values reflecting a willingness to pay to conserve the option of making use of the forest even though no current use is made of it.

(d) Non-use values (also known as existence or passive-use values): these values reflect a willingness to pay for the forest in a conserved or sustainable use state, but the willingness pay is unrelated to current or planned use of the forest.

There are other notions of values, for example, moral or ethical value, spiritual and religious value and cultural value. Moral and ethical values tend to relate to 'intrinsic' qualities of the forest and are generally not subject to quantification. The same is true of spiritual and religious values whereby forests embody characteristics venerated by individuals and communities. There are, however, links between these notions of value and economic value. In particular, non-use values are known to reflect many different motivations, motivations that include the individual's concern for intrinsic values. But notions of values based on intrinsic qualities are different to economic values in that the latter are always 'relational' i.e. they derive from human concerns and preferences and are therefore, values conferred by human beings.

Stakeholder analysis analyses the individuals, groups and institutions with an interest ('stake') in forests, assesses the nature of that interest, the impacts that such stakeholders have on forest integrity and ways in which those interest can be served in a sustainable manner. Table below sets out the classification of forest values and interests that various stakeholders have in those values.

Forest values and stakeholder interests

Direct use value	Main stakeholders and their interest	Impact on forest integrity
Timber	Logging companies (profit) Government (royalties)	Often unsustainable Usually low tax-take
Fuelwood	Local communities (high value)	Usually sustainable
NTFPs	Local communities (high value)	Usually sustainable
Genetic information	Plant breeding companies (profit)	Sustainable
-Agriculture	Drugs companies (profit)	Sustainable
-Pharmaceutical	Local communities (medicines)	Sustainable
Recreation	Tourism (revenue leakage issue) Nearby urban dwellers	Usually sustainable Sustainable
Research/education	Local and international universities	Sustainable
Cultural religious	Local communities	Sustainable
Indirect use values	**Main stakeholders and their interest**	**Impact on forest integrity**
Watershed functions		
Soil conservation	Local and regional communities	Usually unappropriated
Water supply	Local and regional communities	Usually unappropriated
Water quality	Local and regional communities	Usually unappropriated
Flood protection	Local and regional communities	Usually unappropriated
Global climate		
Carbon storage	Global community (Climate protection)	Favours conservation
Carbon fixing	Local community (carbon trades) Global community (climate protection)	Favours conservation Favours conservation

Forest values and stakeholder interests contd.

Biodiversity	Local communities	Favours conservation
Amenity (local)	Nearby residents	Unappropriated benefit
Forest value	**Main stakeholders and their interest**	**Impact on forest integrity**
Option and existence value	Global community debt for nature swaps, donations, forest funds, GEF etc) local and regional communities	Appropriable Not usually appropriated
Land conservation values	**Main stakeholders and their interest**	
Crops	Agriculturists	Inconsistent with forest conservation
Pasture	Ranchers: Local communities Private business	Inconsistent with forest conservation
Logging	Logging companies Governments	Generally unsustainable
Agro-forestry	Local communities	Potentially sustainable
Agri-business	Private companies	Inconsistent with forest conservation
Aquaculture (mangrove)	Private companies Local communities	Usually inconsistent with mangrove conservation

Source: CBD (2002)

An important feature of the table is that forest conservation values can accrue to local communities (e.g. shifting agriculture) but that such practices are increasingly unsustainable as less open access forest is available. The effect of the 'diminishing frontier' is that fallow plots are revisited before regeneration has fully occurred, so that second and third round crop production takes place on increasingly 'mined' soils. Indigenous peoples and local communities may benefit at least in the short term from other conversion activities, e.g. employment from logging operations. Often, however, the converted land use involves ownership by other agencies, e.g. national or regional government and larger corporations, with the effect of displacing local communities. For indigenous peoples this can also create and trigger far-reaching social and cultural disruption, without opportunities for earning money.

The table also illustrates that local communities benefit substantially from forest goods and services. In particular, fuelwood and other NTFPs can account for a major fraction of local community income. Communities could benefit further from the monetization of carbon storage and sequestration flows through private carbon trades and/or trades as envisaged in the flexibility mechanisms of the Kyoto protocol. The same is true of market creation in watershed protection benefits, as shown in Costa Rica's Forest Law of 1996, and in the formalization of intellectual property rights in genetic information under the Convention on Biological Diversity. Local communities might therefore be beneficiaries of processes designed to appropriate the benefits from forest non-market values. The inverse of this proposition is also true – they are likely to be the major losers from processes that continue to convert forest land.

However, there are many potential negative impacts with these flexibility mechanisms, such as displacement of indigenous peoples and local communities from their lands, forest destruction, denial of land and land use rights, commercialization and monetization without corresponding development opportunities.

2.1.2 Direct use values

The value of forests is most commonly associated with the production of timber and fuelwood. These are major products for many countries, providing building materials, energy, pulp and paper, industrial raw materials and valuable foreign exchange. Estimates by FAO (2001), show that global production of roundwood reached 3335 million m^3 in 1999, a little more than half of which is used for fuelwood and the remainder for industrial roundwood.

2.1.3 Timber values

Two types of timber use to be distinguished: commercial and non-commercial. Local uses may be commercial or can relate to subsistence, e.g. building poles. World industrial roundwood production expands substantially between 1960 and 1990 from some 1.0 billion m^3 to 1.6 billion m^3 but has since fallen back to some 1.5 billion m3 in the late 1990s (FAO, 2001). Tropical wood production in 19999 represented a relatively small proportion of overall global production of the various commodities: about 15% of the world's industrial roundwood production, 14% of sawnwood, 15% of wood-based panels and 9% of paper and paperboard (FAO, 2001). Industrial roundwood production in 1999 was dominated by developed countries, which together accounted for 79% of total global production. Industrial roundwood production varied from year to year during the 1990s, but the overall trend was relatively flat. This was a significant change from the rapid growth that occurred prior to 1990. Wood-based panel and paper/paperboard production show a steadily rising demand, which is partially offset by reductions in the demand for sawnwood.

Fibre production has risen nearly 50% since 1960 to 1.5 billion m3 annually. In most industrial countries, net annual tree growth exceeds harvest rates; in many other regions, however, more trees are removed from production forests than are replaced by natural growth. Fibre scarcities are not expected in the foreseeable future. The potential for forest plantations to partially meet demand for wood and fibre for industrial use is increasing. Although accounting for only 5% of global forest cover, forest plantations were estimated, in the year 2000, to supply about 35% of global roundwood, with an anticipated increase to 44% by 2020. In some countries, forest plantation production already contributes the majority of industrial wood supply (Carle *et al*., 2001)

In a comprehensive survey of sustainable forestry practice, Pearce *et al*., (2001) found that sustainable forest management is less profitable than non-sustainable forestry, although problems of definition abound. Profit here refers only to the returns of logging regime and do not include the other values of the forest. Sustainable timber management can be profitable, but conventional (unsustainable) logging is more profitable. This result is largely due to the role that discount rates play in determining the profitability of forestry. The higher the discount rate the less market value is attached now to yields in the future. If logging can take place in natural forests with maximum harvest now, this will generate more near-term revenues than sustainable timber practice. Similarly, sustainable timber management involves higher costs, e.g. in avoiding damage to standing but non-commercial trees. The non-timber benefits, including ecological and other services, from sustainable forests must exceed the general loss of profit relative to conventional logging for the market to favour sustainable forestry. The conclusion was also supported by a study of tropical forests in Peru, by Rice *et al*., (1997).

2.1.4 Fuelwood and charcoal

FAO (2001) statistics suggest that, in 1999, some 1.75 billion m^3 of wood was extracted from forests for fuelwood and conversion to charcoal. Of this total, roughly one-half came from Asia, 26% from Africa, 10% from South America, 8% from North and Central America, and 5% from Europe. The International Energy Agency (1998) estimates that 11% of the world's energy consumption comes from biomass, mainly fuelwood. IEA (1998) estimates that 19% of China's primary energy consumption comes from biomass, the figure for India is 42%, and the figure for developing countries is generally about 35% (UNDP 2000).

All sources agree that fuelwood is of major importance for poorer countries and for the poor within those countries. While fuelwood may be taken from major forests, much of it comes from woodlots and other less concentrated sources. Extraction rates may or may not be sustainable, depending on geographic region. Almost no fuelwood and charcoal is traded internationally.

As with other non-timber products local values of fuelwood and charcoal can be highly significant in terms of the local economy. Shyamsundar and Kramer (1997) show that the value of fuelwood per household per annum for villages surrounding Mantadia National Park in Madagascar is $39. This can be compared with an estimated mean annual income of $279, i.e. collected fuelwood from the forest accounts for 14% of household income. Houghton and Mendelsohn (1996) found that the value of fuelwood constitutes from 39-67% of local household income from fodder, fuel and timber in the Middle Hills of Nepal.

2.1.5 Non-timber forest products

NTFP extraction may be sustainable or non-sustainable and few studies make observations as to which is the case. One example of sustainable use is Sinharaja Forest

Reserve in Sri Lanka, where the most popularly collected NTFPs (*Galamus* species/rattans, *Caryota urens*/kithul palm used for jiggery production, wild cardamom and a medicinal herb, *Costcinium fenestratum*) all performed better in undisturbed forest, where they were either absent or showed growth (Gunatilleke *et al*., 1995).

Extractive uses include: taking mammals, fish, crustaceans and birds for local or international trade or for subsistence use, taking plants products such as latex, wild cocoa, honey, gums, nuts, fruits, flowers/seeds, berries, fungi and spices, also plant material for local medicines, rattan and fodder for animals. Detailed analysis of the available studies suggests that economic values of NTFP (net values, i.e. net of costs) cluster from a few dollars per hectare per annum up to around US$100/ha/yr. Lampietti and Dixon (1993) suggested a 'default value of around US$70 per hectare, and Pearce (1998) has suggested US$50. However, these values cannot be extrapolated to all forest. Typically, the higher values relate to readily accessible forests, values for non-accessible forests would be close to zero in net terms due to the costs of access and extraction.

The benefits of NTFPs accrue mainly to local communities. The size of the population base making use of the forests may be comparatively small and the implied value per hectare may therefore also be small due to the unit values being multiplied by a comparatively small number of households. It is important to discern, as far as possible, what the value of NTPFs is a percentage of household incomes. Available studies suggest NTFPs may account for 30-60% of local community household income and in some cases the amount exceeds 100% of other income. This perspective demonstrates the critical importance of NTFPs as a means of income support. Indeed, it underlines (a) the need to ensure that measurements of household income include the non-marketed products taken 'from the wild' and (b) the role that NTFPs play in poverty alleviation.

2.1.6 Indirect use values

2.1.6.1 Watershed protection

Watershed protection functions include: soil conservation and hence control of siltation and sedimentation; water flow regulation, including flood and storm protection; water supply and quality regulation, including nutrient outflow. The effects of forest cover removal can be dramatic if non-sustainable timber extraction occurs, but care needs to be taken not to exaggerate the effects of logging and shifting agriculture (Hamilton and King, 1983) or permanent conversion to agriculture. Available studies suggests that watershed protection values appear to be small when expressed per hectare, but it is important to bear in mind that watershed areas may be large, so that a small unit value is being aggregated across a large area. Secondly, such protective functions have a 'public good' characteristic since the benefit accruing to any one household or farmer also accrue to all others in the protected area. Third, the few studies available tend to focus on single attributes of the protective function - nutrient loss or flood prevention etc. The aggregate of different protective function is the relevant value. Fourth, the Hodgson and Dixon study (1988) for the Philippines suggests that fisheries protection values could be substantial in locations where there is a significant in-shore fisheries industry. Comprehensive estimates have still to be researched.

2.1.6.2 Carbon storage and sequestration loss rates for tropical forests.

An average closed primary forest has some 280 tonnes/ha of carbon and if converted to shifting agriculture would release about 200 tonnes of this, and a little more if converted to pasture or permanent agriculture. Open forest would begin with around 115 tC and would lose between a quarter and third of this on conversion. Using such estimates as benchmarks, the issue is what the economic value of such carbon stock is. A significant literature exists on the economic value of global warming damage and the translation of these estimates into economic value of a marginal tonne of carbon. A recent review of the literature by Clarkson (2001) suggested a consensus value of US$34/tC. Tol *et al.*, (2000) also review the studies and suggest that it is difficult to produce estimates of marginal, damage above US$50/tC. Taking US$34-50/tC as the range produces very high estimates for the value of forests as carbon stores. In practical terms, however, a better guide to the value of carbon is the price at which it is likely to be traded in a 'carbon market'. Carbon markets have existed since 1989 and refer to the sums of monies that corporations and governments have been willing to invest in order to sequester carbon or prevent its emission. More sophisticated markets will emerge as emissions trading schemes develop under Kyoto Protocol. Zhang (2000) suggests that, if there are no limitations placed on worldwide carbon trading, carbon credits will exchange at just under US$10 per tC. At this carbon 'price' tropical forest carbon storage would be worth anything from US$500 per hectare to US$2000/hectare, confirming the view of a number of commentators that carbon values could easily dominate the economic values of tropical forests. Carbon regimes in temperate countries have also been extensively studied and afforestation carbon values probably range from about US$100 to $300/ha. These sums are 'one off' and therefore need to be compared to the price that is paid for forest for conversion to agriculture or logging. In most cases, carbon storage is more than competitive with conversion values. These values relate to forests that are (a) under threat of conversion and (b) capable of being the subject of deforestation avoidance agreements.

2.1.6.3 Option and existence values

There are three contexts in which option and existence values might arise: (a) someone may express a willingness to pay to conserve the forest in order that they may make some use of it in the future, e.g. for recreation. This is known as an option value, (b) someone may express a willingness to pay to conserve a forest even though they make no use of it, nor intend to. Their motive may be that they wish their children or future generations to be able to use it. This is a form of option value for others' benefit, sometimes called a bequest value, (c) someone may express willingness to pay to conserve a forest even though they make no use of it, nor intend to, nor intend it for others' use. They simply wish the forest to exist. Motivations may vary, from some feeling about the intrinsic value of the forest through to notions of stewardship, religious or spiritual value, the rights of other living things, etc. This is known as existence value.

There are few studies of the non-use values of forests. The available evidence suggests that (a) existence values can be substantial in contexts where the forests in question are themselves unique in some sense, or contain some form of highly prized biodiversity – the very high values for sported owl (*Strix occidentalis*) habitats illustrates this; and (b) aggregated across households, and across forests generally, existence values are modest when expressed per hectare of forest.

2.1.7 Tourism and recreation values

Ecotourism is a growing activity and constitutes a potentially valuable non-extractive use of tropical forests. Caveats to this statement are (a) that it is the net gains to the forest dwellers and/or forest users that matter; (b) tourism expenditures often result in profits for tour organizers who do not reside in or near the forest area, and may even be non-nationals; (c) the tourism itself must be 'sustainable' honouring the ecological carrying capacity of the area for tourists. In principle, tourism values are relevant for any area that is accessible by road or river. Some forest ecotourist sites attract enormous numbers of visitors and consequently have very high per hectare values. Values clearly vary with location and the nature of the attractions and none of the studies available estimates the extent to which expenditures remain in the region of the forest. For tropical forests, values range from a few dollars per hectare to several hundred dollars. A substantial number of studies exist for the tourism and recreational value of temperate forests. Indicative values for European and North American forests suggest per person willingness to pay of around $1-3 per visit. The resulting aggregate values for forests could therefore be substantial. Elasser (1999) suggests that forest recreation in Germany is worth some $2.2 billion per annum for day-users alone and a further $0.2 billion for holiday visitors.

2.1.8 Forests biodiversity

Besides supplying timber and other forest products, forests have a vital effect on processes of great significance for people. They influence local and regional climates, generally by making them milder, and they help to ensure a continuous of clean water. Some forests, notably tropical cloud forests, even increase the availability of water by intercepting moisture from clouds. Watershed forests are particularly important because they protect soil cover on site and protect areas downstream from excessive floods and other harmful fluctuations in stream flow. By thus reducing the silt load of rivers, watershed forests also helps prevent the clogging of reservoirs, irrigation systems, canals and docks, and the smothering by sediments of coral reefs.

Yet watershed forests are being widely devastated by clearance for agriculture, by logging and cutting for fuel, by grazing, and by badly managed road building. The results can be extremely expensive. It costs Argentina $ 10 million a year to dredge silt from the estuary of the River Plate and keep Buenos Aires open to shipping. Eighty percent of the 100 million tones of sediment that every year threatens the harbor come from only Four percent of the drainage basin, the heavily overgrazed catchment area of Bermejo River 1,800 Km upstream. (Pereira, (1973). In India the annual cost of damage by floods ranges from $140 million to $750 million.

Sedimentation as a result of careless use watershed can cut drastically the life of reservoirs, hydroelectric facilities and irrigation systems. The capacity of India's Nizam-sagar reservoir has been halved (from almost 900 million m3 to fewer than 340 million m3) and there is now not enough water to irrigate the 1,100 Km2 of sugarcane and rice for which it was intended and hence not enough sugarcane to supply local sugar factories. Deforestation in northern Luzon in the Philippines has silted up the reservoir of the Ambuklao Dam so fast that its useful life has been reduced from 60 to 32 years (USAID, 1979). Such problems are not confined to developing countries, for example, it has estimated that more than 1,000 million m3 of sediment are deposited every year in the major reservoirs of the USA (Holeman, (1968). Although they have not been calculated (indeed, probably cannot be), the global costs of sediment removal, river dredging, reconstruction of irrigation systems and loss of investment in expensive structures like dams must be huge. Only 10% of the world's populations live in mountainous areas, but another 40% live in the adjacent plains (FAO, 1978); so the lives and livelihoods of half the world directly depends on the way in which watershed ecosystems are managed.

In areas under shifting cultivation forests also act to restore soil fertility. More than 200 million people occupying about 30 million Km2 of tropical forests live by practicing shifting cultivation. The fallow period lasts from 8-12 years in tropical rain forests to 20-30 years in drier areas, and during this time the forest cover enables the soil to regenerate. This is a stable, productive practice if the population itself is stable; but if populations are growing, which nowadays they usually are, the pressure on land increases, fallow periods shorten, the soil has no chance to regenerate, and wider and wider tracts of otherwise productive forest land are destroyed. Almost two-thirds of land under shifting cultivation is upland forest, much of it on steep slopes, and the resulting erosion is severe (FAO, 1978). In the Ivory Coast, shifting cultivation reduced the forest cover by 30% between 1956 and 1966 and now only 50,000 km2 remain out of the 150,000 Km2 that is believed to have existed at the beginning of this century (FAO, 1978). Similarly, shifting cultivators clear about 3,500 Km2 a year in the Philippines, in Mindanao alone they cleared 10,000 Km2 between 1960 and 1971(FAO, 1971).

2.1.9 Distribution of World's Forest

The area of the world's forest, including natural forest and forest plantations, was estimated to be 3869 million ha in 2000, equivalent to almost 30% of the ice-free land area of the earth (FAO, 2001). The three major forest biomes are boreal, temperate and tropical. In terms of area, the forests are roughly equally divided between tropical/sub-tropical forests and temperate/boreal forests. The remaining closed forests amount to 21.4% of the Earth's land area and occur predominantly in boreal forests (1000 million ha) and tropical areas (680 million ha); other remaining forests (1820 million ha) are fragmented (UNEP 2001).

The majority of the forested area consists of natural forest (95%), with commercial plantations comprising 3% and other forest plantations making up the remaining 2% (Carle et al., 2001; FAO 2001). Under the FAO definition, natural forest include all forest "composed of indigenous trees, not planted by man or in other words, forests excluding plantations", while plantations include "forest stands established by planting or/and seeding in the process of afforestation or reforestation. They are either introduced species (all planted stands) or intensively managed stands of indigenous species, which meet all the following criteria: one or two species at plantation, even age class, regular spacing". A little over half (55%) of the world's forest are located in developing countries. Two-thirds are found in only ten developing countries: Brazil has 544 million ha, Indonesia 105 million, Democratic Republic of Congo 135 million ha, Peru 65 million ha, India 64 million ha, Mexico 55 million ha, Bolivia 53 million ha, Colombia 50 million ha, Venezuela 50 million ha and Sudan 42 million ha. More than three quarters of the temperate and boreal forests are situated in just four countries: Russian Federation 851 million ha, Canada 245 million ha, USA 226 million ha and China 163 million ha. At the global level about 30,350 protected areas have been established, covering 8.8% of land area (IUCN, 1998). Green and Paine (1997) have endeavoured to estimate the extent to which major biomes, including various categories of forest, are represented in the global protected areas network. In this analysis, tropical forest types are better represented in protected areas than temperate forest types, mainly due to more extensive deforestation over a longer period in temperate regions of Eurasia. The overall figures for tropical forests appear satisfactory, approximating the 10% target established at the IV World Parks Congress (IUCN, 1993), but in reality overestimate the extent to which forest ecosystems are being properly conserved in protected areas.

A survey of 10 developing countries with major forest resources found that only 10% of forest protected areas are secure in the long-term, with 60% currently secure but with threats likely in the near future and more than 20% are suffering from degradation, (Dudley and Stolton, 1999).

2.1.10 Status of Biodiversity in Forest Biomes

Forest biological diversity can be quantified at several scales, these include: assessing the genetic components within species, counting the number of species per unit area (local, regional, national, continental, global), determining numbers and arrangement of forest types and their age, classifying types of forest ecosystems, determining communities of species associated with forest ecosystem and describing landscape structure (UNEP, 1995).

2.1.11 Boreal forests

Boreal Forests, including tundra woodlands, extend over about 1270 million hectares, or about one third of the world's forest cover. The boreal forest is the second largest terrestrial biome after tropical forests. This northern circumpolar biome is strongly characterized by coniferous ecosystems with low tree species richness, extensive and fairly uniform stands and relatively short-lived species (<200 years), which are under fire, wind and insect disturbance regimes. Extreme oceanic types with broad-leaved deciduous tress are found in northwestern Europe, where the tree limit is formed by *Betula pubescens* subsp. *czerepanovii*. Similar ecological conditions prevail in northern Asia, Alaska, and northern Canada, with stunted *Picea, Larix, Pinus pumila* and *Betula nana* at the treeline.

Boreal landscapes are composed of a complex of plant communities that, aside from vast tracts of forest stands, include various wooded and open mires of bogs, numerous water bodies of varying size, rivers, rock outcroppings and natural grasslands and ferns (Walter, 1979; Barbour and Christensen, 1993).

The Wisconsin glacial events, 10,000- 14,000 years ago, forced plant and animal life south, followed by northward migration, in recurrent cycles.

The boreal forest biome is distributed across areas formerly covered by continental glaciers and, consequently, the land has supported forest cover for only 3,000 to 7,000 years (Ritchie 1987). The number of tree species that characterise these forests is therefore low, especially in the Euro-Siberian area, where major watercourses and mountain ranges run at right angles to the direction in which the species migrated northwards. As a result of the post-glacial history of the biota, many boreal and subarctic tundra species have wide distributions. There are relatively few endemics at the species level; most of these occur these occur in the extreme eastern and western parts of the continents, close to ancient refuges. Due to wide distributions and varying environmental conditions, evolution at the level of ecotypes and subspecies is common and some genera, such as *Carex* and *Betula*, show wide-scale hybridization (Jonsell, 2000).

Boreal forest stands normally contain no more than a few species, primarily of the genera *Picea, Pinus, Abies, Larix, Thuja, Betula, Prunus, Alnus* and *Populus*, and they often form monocultures, particularly in the case of *Picea, pinus* and *Larix*. These genera are panboreal and members of the four deciduous genera (*Betula, Prunus, Alnus* and *Populus*) grow more rapidly than conifers and tend to occupy sites immediately following stand disturbance. Tree richness in North American forests is greater than in the Euro-Siberia region. In North America, four of the six principle boreal forest species extend across the continent, though no single tree species is panboareal. *Picea mariana* grows on poor soils and forms the northern treeline continent-wide. Where fire is uncommon, *Abies spp*. often predominates in the eastern and continental North American boreal zone. In Eurasia, this genus is ecologically largely replaced by two species of *Larix*. Larch forest, mostly consisting of *Larix gmelinii*, covers 2.5 million km^2 in continental Siberia where much of the terrain has deep permafrost. *Larix sibirica* often forms monotypic stands following disturbance by fire (Schulze *et al*., 1996). While in North America, *Larix laricina* is rarely a dominant species, and is found mainly in cold, wet and poorly drained sites such as in *sphagnum* bogs and muskeg. In Europe, only *Picea abies* and *Pinus sylvestri* are true dominants of the boreal zone, and are often mixed in successional phases with broad-leaved deciduous tree species such as *Betula pendula*, *B. pubecens*, *Populus termula* and *Alnus glutinosa* and *A. incana*. In more eastern European regions, *Picea abies* is replaced by the closely related *Picea obovata*, with *Abies sibirica, Larix sibirica* and *Pinus cembra* subsp. *sibirica*. There is a broad belt of hybrids, *Picea abies* x *P. obovata*, between their natural regions. In Eurasia, the proportion of *Picea* gradually decreases eastward while that of *Larix* increases correspondingly. In northern Japan, the number of coniferous species increases again.

Conifers comprise the bulk of the biomass in these boreal ecosystem, although most forests also include a variety of deciduous trees and shrub species, dwarf-shrubs (notably member sof the Ericacea), grasses, sedges and herbs. In general, species diversity in taiga communities increases with length of the growing season, increasing soil fertility and favourable drainage. A comparatively moderate richness of bryophytes, lichens and fungi occur in many boreal forest types, they are especially common in older forest with their volume of decaying wood.

Animal species richness generally declines with increasing latitude, and boreal forests maintain fewer species than do temperate or tropical forests. Studies have shown a longitudinal gradient in the species richness of herbivores, with the region near the Bering Sea being particularly species poor (Danell *et al*., 1996). The fact that this region supports the woody species most chemically defended against browsing suggests that such gradients of plant chemical defence in boreal forests may be also partly responsible for gradients of mammalian species richness (Pastor *et al*., 1996). An important and characteristic component of boreal fauna is migratory birds which breed in summer in the boreal forest and winter in more southern areas. In many cases, these tropical and neo-tropical migrants travel thousands of kilometers between their winter and summer ranges. Species which must over-winter in northern forests have developed a range of adaptations to cold climates including hibernation, thick fur, denning beneath the snow, and the ability to maintain life with reduced availability and quality of forage, such as by storing fat in the fall and then losing weight over-winter. Caribou or reindeer (*Rangifer tarandus*) can make use of lichens, a group of species not fed upon by other boreal animals. Large predators still remain common in Canada, Alaska USA, (bears *Ursus Americana*, *Ursus arctos*, wolf *Canis lupus*) and Russian boreal forests (wolf and tiger *Panthera tigris altaica*), but are absent from Scandinavia, although wolves have been recorded over the past decade. The large ungulates species are panboreal, including moose (*Alces alces*) and caribou. Food webs are not complicated and are a few common herbivores dominate the deits of all predators, avian and mammalian. Small herbivores (and their predators) in boreal systems are well-known for their periodicity, or even cycling (e.g., Krebs *et al*. 1995, Stenseth *et al*. 1998), which appears related to both food availability and predation rate. The dominant cycle length for a wide variety of mammals and birds in North America appears to be about ten years, while in Fennoscandia its length is usually four years (Keith, 1963; Finerty, 1980; Erlien and Tester, 1984). Such fluctuations represent a temporally dynamic aspect of biodiversity. Cycles of herbivores may result in differential survival of their preferred food species, such as fir, aspen and birch, as well as their predators, such as warbles that prey on budworm (*Choristoneura fumiferana*), or Canada lynx (*Lynx Canadensis*) that prey on small mammals (Keith, 1963; Hansson, 1979; Haukioja *et al*., 1983; Bryant and Chapin, 1986; McInnes *et al*., 1992; Stenseth *et al*. 1998; Thomas *et al,* 2007).

There appears to be relatively few vertebrate animal species with highly restricted habitats or niches in boreal forests, although several species relying on dead wood or cavities to nest or breed find old forest to be optimal habitat (Thompson and Angelstam 1999). Relatively few boreal species are listed by IUCN (2000) as threatened, however, several of the large carnivores such as Siberian tiger and brown bear are threatened.

2.1.12 Temperate forests

The temperate forest biome, located in the mid-latitudes, occupies a climatic zone with pronounced variations in seasonal temperatures, characterized by distinct winter and summer seasons, but with a daily mean temperature over 10^{o}C for more than 120 days (Walter, 1979). This biome occurs primarily in the northern hemisphere, while in the southern hemisphere, it is limited to the southern part of the Andes in Chile and in portions of New Zealand, South Africa and southern Australia. Temperate forests are dominated by deciduous tree species and, to a lesser extent, evergreen broad-leaf and needle-leaf species (Melilo *et al*, 1993). More than 50% of the original temperate forest cover has been converted to agriculture (Matthews, 1983). Unfortunately, most forest statistics do not distinguish between natural forest, secondary forest and plantations. Occurrence of temperate forests is highly concentrated in the Russian Federation alone holding over 41% of the world's temperate forests. However, from an ecological perspective, some of smaller temperate forests are critical sources of biological diversity, including for example, those in parts of Europe, Australia, South Africa and geographically isolated and highly endemic natural forests of New Zealand.

In Europe, temperate forests extend over some 160 million ha, which represents slightly less than half of the original forest cover. In Western Europe, it is estimated that the extent of remaining old growth and semi-natural forest is only 0.8% of the original forest cover (Mathews, 1983). Eastern Europe has more old growth forest than in the west (Ryzkowski *et al*., 1999). In the United states, less than 2% of the original temperate forests remain, although proportions vary regionally. For example, the states of Washington and Oregon have 13% old growth temperate forests remaining. In British Columbia, Canada, almost 40% of the original natural forests remain, although some of these are subject to intensive forest management (Canadian Council of Forest Ministers, 2000). New Zealand retains less than 24% of its native forests (Clout and Gaze, 1984) and in Australia, the amount of the original temperate forest varies from 5-20%. In some temperate areas of developing countries, there is a net loss of forest cover, Chile, for example, loses about 20,000 ha/year (FAO, 2001).

The annual productivity of natural northern temperate forests is about900 to 1000 g/m^2 but 1000 to 1400 g/m^2 in old southern temperate forests of North America (Lieth and

Whitaker, 1975). However, there is obviously a large variation associated with these figures depending on site, elevation, type and age of forest. Mediterranean forests constitute a distinct sub-zone of temperate biome and occur between 30 and 40 degree latitude on the west and south-west coasts of the continents. Their climate is characterized by hot, dry summer and mild, moist winters. The Mediterranean sub-zone in the Americas occupies coastal California in the United States and the coastal region of Chile. In Africa, similar forests extend around the Cape of Good Hope; and also occur in the southern part of Australia. However, the largest Mediterranean sub-zone is located around the Mediterranean Sea and includes the southern part of Europe, the south-west part of Asia and north coast of Africa. In Europe, the Mediterranean sub-zone has been the cradle of several civilizations, one replacing another over centuries, and this has resulted in a long history of extensive environmental change as a result of economic, cultural and social activities. The area surrounding the Mediterranean Sea was originally covered with forest of *Cedrus libani*, *Quercus ilex, Quercus cerris, Arbutus unendo, Pinus halepensis, Pinus nigra*, but the Mediterranean hillsides were transformed hundreds of years ago into terraces of fruit orchards, gardens, olive tree and fig tree plantations, as well as human settlements. Areas that have escaped cultivation are covered with shrubs and bushes, resulting in *Maccia (maquis*), a woody secondary vegetation cover (Ovington, 1983). Few areas of original forest remain, and in particular the formerly important forest areas of Turkey, Greece, Lebanon, Israel Iraq and Syria have been decimated by many centuries of human exploitation.

More than 1200 tree species are represented in temperate biome (Ovington, 1983; Schulze *et al*., 1996). Globally, temperate deciduous forests maintain a large variation in species richness, resulting largely from climates and differences in geological history. During the Tertiary period (3 million years+ ago), the three deciduous forest regions of the northern hemisphere are thought to have had a fairly uniform tree flora. Europe and North America were still closely related floristically and there were also many common species in Europe and Asia (Walter and Straka, 1970). However, during the Pleistocene glaciations, the east to west orientation of mountain systems, such as the Alps, the Caucasus and the Himalayas, apparently formed a barrier, resulting in the Euro-Siberian flora being reduced as many species could not survive the cold in various refugia. However, in North America, the mountain chains are oriented north to south, enabling easy migration, so most species survived the glacial periods in southern locations (Ritchie, 1987). The highest temperature species post-glacial survival, and hence current diversity, is in Asia (Ohsawa, 1995), with four times the number of tree species there than in North America (Huntely, 1993).

East Asia's forests are very rich in woody plant species, with almost 900 trees and shrubs. That is almost six times greater than in North America, where the second most diverse temperate forests occur. The temperate forests of Europe are more impoverished, with just 106 tree species and significantly fewer families and genera than in North America. The southern hemisphere generally has even fewer species than Europe (except for Australia with its high diversity *of Eucalyptus* and *Acacia* species), but there is high endemism with most species belonging to different families from those found in the northern hemisphere, suggesting major differences in evolutionary history. Transition zones between tropical and temperate forest biomes, are comparatively species rich. These occur, for example in Japan and southern United States, where temperate lowland forests merge with subtropical evergreen broad-leaf forests. In southern Canada, the maximum tree species richness in temperate forests is approximat ely 60 species, but by mid-latitudes in eastern United States, the same biome contains over 100 species, illustrating the general latitudinal relationship of species diversity, i.e. diversity increasing towards the equator (Stevens, 1989).

Temperate forests tend to support their largest variety of species on nutrient-rich soils, and species richness also seems to be greater on alkaline and neutral soils than on acid soils (SCOPE, 1996). Local species richness in many of these forests is highly variable, ranging from monocultures to multi-species forests. In many areas of the temperate biome, large stands of deciduous forests may be composed of a single tree species. For instance, *Fagus sylvatica* dominates deciduous forests in Europe; *F. orientalis* forms nearly pure stands in the wetter regions of Japan. In Europe, on calcareous soils with high water tables, *Quercus* and *Carpinus* become dominant rather than *Fagus*. In North America, *Fagus* rarely dominates forests, but pure stands of *Betula* and *Populus* are common, as is the case in Siberia and northern Japan. *Nothofagus* occurs in monocultures in New Zealand and South America. *Quercus* and *Pinus* are global species found in most northern hemisphere temperate forests. In Australia, forests are dominated by extremely diverse genus *Eucalyptus* with more than 70 species in 16 forest types (Ovington and Pryor, 1983) whereas *Quercus* is absent. Although alpha-diversity (patch-scale or within-site diversity) may be low, beta-diversity (regional or among-site diversity) in the temperate biome forests can be quite high.

In North America, an important temperate coniferous forest belt occurs along most of the west coast from Alaska southwards to northern California. The forests lie on the windward side of the coastal mountain chain, which runs the length of the continent. The forests, collectively referred to as temperate rainforests, exhibit a high level of biological diversity with a large number of endemic plants and animals (Ruggiero *et al*., 1991; Castellon and Siering, 2007). They are characterized by several long-lived tree species (>100 year) and contain the tallest trees in the world (to 95m), including: *Sequoia sempervirens*, *Sequoia gigantean*, *Pseudotsuga menziesii*, *Pica sitchensis*, *Tsuga heterophyla*, *Thuja plicata* and *Chamaecyparis nootkatensis* (Maser, 1990). The management of the temperate rainforests forests has generated more controversy than any of the other North American forest types because of their species diversity, complex functioning and the particularly majestic characteristics of the old-growth trees, which can exist for many centuries in a gap-phase dynamic condition (Maser, 1990).

As with boreal forests, the fauna of temperate forests, especially the birds and mammals, can have a wide distribution and even extend to other biomes. For example, Neotropical migrants' birds of North America, numbering about 250 species, make the annual trip from the tropics to the temperate regions, and changes in the extent and condition of either forest biome can affect the populations of these birds in both continents. Survival of these birds is important because smaller numbers may allow defoliating insects to reach epidemic proportions more frequently and this further endangers the survival of some species (UNEP, 1995). Not all temperate forests host fauna with such a wide distribution. In the forest of southern South America, Southeast Asia, Australia and New Zealand, there are many endemic species of mammals and birds that are highly localized.

More animal species have become extinct in the past 100 years, or have their range and population substantially reduced, in the temperate forest biome than in the other biomes (Hilton-Taylor, 2000). Falling particularly into this category are the large ungulates including extinct aurochs (*Bos Taurus*) and tarpan (*Equus gmelini silvaticus*), endangered bison (*Bison bonasus*) and declining fallow-deer (*Cervus dama*) and moufflon (*Ovis musimon*) in Eastern Europe. The general reduction of forest cover, combined with hunting and/or trapping, has caused the reductions of many large carnivores such as the brown bear (*Urus arctos*), lynx (*Felis spp.*), cougar (*Puma spp.*) glutton or wolverine (*Gulo gulo*) and wolf (*Canis spp.*) (Hilton-Taylor, 2000; Pimm *et al.*,1995). Within the past 20 years in North America, the passenger pigeon (*Ectopistes migratorius*), Carolina parakeet (*Cornuropsis carolinensis*), ivory-billed woodpecker (*Campephilus principalis*), Bachman's warbler (*Vermivora bachmanii*) and the eastern cougar (*Puma concolor*) have become extinct (Pimm *et al.*, 1995).

The USA has the highest number of threatened species as listed by IUCN (2000) at 997 species, with most of these occurring in temperate ecosystems.

2.1.13 Tropical forests

In the tropical forest biome, three major regions are recognized: American, African and Indo-Malaysian (Whitmore, 1984,1990). Tropical forests may be broadly classified as moist or dry, and further subdivided into rainforest (some 66% of the tropical moist forest), cloud forest, evergreen season forest, semi-evergreen tropical forest, moist deciduous forest (monsoon forest), dry deciduous forest, and mangrove Rainforests occur in Central and South America, Africa, the Indo-Malaysian region and in Queesland, Australia. Where several dry months (60 mm rainfall or less) occur regularly in the tropics, monsoon or season forests (closed forests) have together been termed “tropical moist forest” (. Cloud forests situated at middle to high altitudes derive a significant part of their water supply from cloud and fog, and hence these support a rich abundance of vascular and nonvascular epiphytes. The evergreen seasonal forest are found in regions where every month is wet (100 mm rainfall or more) and in areas with only short dry periods (Whitmore, 1990; Sahney *et al*, 2010).

Dry tropical rainforest were originally described as “evergreen, hygrophilous in character, at least 30 m high in thick-stemmed Ilianas, and in woody as well as herbaceous epiphytes.” Mangroves are the characteristic littoral formations of tropical and subtropical sheltered coastlines, they have been variously describe as “coastal woodland,” “tidal forest” and “mangrove forest.” Basing his work on previous classifications, Whitmore (1990) has, for convenience, grouped the formations within tropical rainforest according to the main physical characteristics of their habitats, noting that the naming of vegetation types is always problematic. In this arbitrary arrangement, the first division is between climates with a dry season and those that are perhumid (for moist forest), the second division (for rain forest), is a crude measurement of soil water availability and distinguishes swamp from drier land forests.

The third division is based on soils and, within dryland forests, distinguishes those on parent materials with atypical properties – peat, quartz sand, limestone, and ultrabasic rocks – from the widespread "zonal" soils mainly ultisols and oxisols. Finally there is a division of the forests on zonal soils by altitude. In the Indo-Malaysian region the tropical rainforest lies as a belt of evergreen vegetation extending through the Malay Archipelago from Sumatra in the west to New Guinea in the east (Whitmore, 1984). This is the non-seasonal humid zone of the Southeast Asian dipterocarp forests. Parches of rainforest, or outliers, are found in southern Thailand, in Sri Lanka, India, northern Queensland in Australia and on the Melanesian islands of the Pacific.

Where seasonality of rainforest occurs, it produces a strong temporal effect on primary production (Orians *et al*, 1996). Productivity varies considerably among the primary tropical forest types; Lieth and Whitaker (1975) and Murphy (1975) provide the following data: tropical rainforest: 1800-3210 g/m^2; cloud forest: 2400 g/m^2; dry deciduous and mixed tropical forests: 1040-1230 g/m^2; for seasonal forest, a single estimate of 1340 g/m^2 from west Africa, and for mangrove: 930 g/m^2 from the Caribbean and 1000 g/m^2 at 10 to 25 years of age at Matang, in Peninsular Malaysia. The rainforest data show a primary productivity 2-4 times greater than that recorded in boreal forests and correlate broadly to a general latitudinal reduction in diversity of plants and animals north from the tropical forest biome.

Tropical forests are the most species rich and diverse forests on earth, estimated to contain at least 50% of all plant and animal species (Myers1986). This is especially true for wet tropical forests, where, for example, some 700 tree species have been recorded in 10 selected 1-hectare plots in Borneo (UNEP, 1975). Estimated number of tree species in the tropics ranges from 17,000 in Africa (Hamilton, 1989) to more than 30,000 in central America (Prance, 1989). However, within tropical moist forests, species richness varies greatly by region and some tropical moist forests actually have relatively low tree species diversity. In the Amazon Basin, for example, less than 90 tree species per hectare have been recorded in the eastern portions compared with nearly 300 species/ha in the western areas (WCMC 1992).

Mangrove forest have relatively low terrestrial species richness, with counts in some river deltas of only about 30 species (IUCN, 2000), although the aquatic life they support is diverse and abundant. African rainforest have fewer plant species than other tropical regions (by about 20%), with several pantropical genera and families (e.g., Lauraceae, Myrtaceae and Palmae) being either absent or poorly represented (Jacobs, 1981). Lianas and epiphytes are also less abundant in Africa rainforests compared to in other tropical regions (Jacobs, 1981).

Few tropical genera are pantropical and endemism is much higher in this biome than in the temperate or boreal forest biomes (UNEP, 1995). For example, in fourteen areas within exceptionally high species richness in the tropics, on about 300,000 km^2., more than 37,000 plant species can be found (Myers, 1990). Tree species richness declines as altitude increases and as climate becomes more seasonal (Orians *et al*., 1996). The mixture of many tree species, with few individuals of each, in a given forest area is a key feature of tropical forests and one which distinguishes them from forests in the boreal and temperate biomes. This feature is significantly related to a predominance of dioecious species and to a seed dispersal relationship with animals in the tropics, compared to boreal and temperate forests where wind is often the medium of seed dispersal (Orians *et al*., 1996). Low density of individual species has particular consequences with respect to the necessity for large areas for preserving populations. (Wardle et al 2011)

Where tropical forests with single dominants do occur (usually dry forest), there are no corresponding species among the regions. In the Americas, *Eperua* and *Mora* dominate such tropical forests, in Africa, *Gilbertiodendron* is a common dominant, dipterocarps dominate in areas of Southeast Asia, in Indo-Malaysia, *Agthis* is sometimes dominant, while in tropical Australia, *Eucalyptus* is dominant genus in low richness stands (Whitmore, 1990). In rainforests, epiphytes, although common to all regions, are highly distinct and certain families predominate (Gentry, 1992), Bromiliaceae and Cactacae in Americas; and Orchidacae, Asclepiadacae and Rubiaceae, in indo-Malaysia. Lianas are another important component of the structure of tropical rainforests, absent from other biomes Gentry, 1992. They make up 8% of the species (in Borneo 150 genera exists) and are indicators of an undisturbed state of forests (Jacobs, 1981). Twelve genera and some 470 species of the family Dipterocarpaceae are found in the rainforests of the Indo-Malaysian region, ranging from Seychelles through Sri Lanka to the south of peninsular India, east to India, Bangladesh, Myanmar, Thailand, Indo-China, to continental South China (Yunnan, Kwangsi, South Kwangtung, Hainan) and through Melanesia (natural botanical kingdom comprising peninsular Malaysia, Sumatra, Java, Lesser Sunda Islands, Borneo, the Philippines, Celebes, the Moluccas, New Guinea and Solomons)(Ashton, 1982).

With the exception perhaps of New Guinea and the eastern part of the region, the tropical rainforests of Indo-Malaysian region are characterized by family dominance of the Dipterocarpaceae. Tropical dry forests generally host lower species richness, with fewer endemics than tropical moist forests, although still significantly higher than in temperate forests. The richest dry forests, found in northeast Mexico and southeast Bolivia, have an average of 90 tree species per hectare (WCMC, 1992). Dry forests are more similar in species richness to their moist counterparts in terms of mammal and insect species. Tropical dry forests are noted for their highly endemic mammal populations, especially insectivores and rodents. An important feature of cloud forests and some other montane forests lies in their high species richness of epiphytes, shrubs, herbs, llianas, and ferns (Gentry, 1992).

These species increase with altitude in the humid tropics whereas in the warmer, lowland tropical forest types, they tend to be less frequent. In addition, cloud forests often contain high numbers of rare endemic plant and animal species or subspecies, such as mountain gorilla (*Gorilla gorilla beringei*) in Central/East Africa, and the quetzal (*Pharamachrus miccino*) of Central America (IUCN, 1995). The percentage of endemic species is even higher in cloud forests on Island Mountains, such as those in Hawaii and in the French overseas territories of Reunion Island and New Caledonia. Mangroves may form very extensive and productive forests. Throughout the tropics, there are about 60 species of trees and shrubs that are exclusive to the mangrove habitat, the important genera being *Avicennia, Bruguiera, Rhizophora, Sonneratia* and *Xylocarpus*. There are also important, non-exclusive associated with the mangroves, including the fern *Acrostichum spp*., and trees such as *Barringtonia racemosa, Hibiscus spp*. and *Thespesia* species.

High species richness in the tropical biome may be the result of the large range of available microhabitats and niches, the absence of mountain systems or their north-south orientation permitting ease of migration and a lengthy period without major disturbance (e.g. glaciations) (UNEP, 1995). Terborgh (1986, 1989) reported that many avian guilds were abundant in the tropics but entirely absent in temperate or boreal biomes including terrestrial frugivores, dead leaf gleaners, army ant followers, and many of the frugivores. High productivity is sustained annually, as opposed to seasonally, in many tropical areas which allows multiple breedings and results in less movement away from home ranges to avoid seasonality (Margaleaf, 1968). Further, in places such as Madagascar and large number of tropical island habitats of Southeast Asia and the Caribbean, a high level of endemism is found because of their isolation (Margaleaf, 1968).

As an important aspect in tropical forests, differing from boreal and temperate forests is the high degree of dioeciousness among trees. The coevolution of tree reproduction with pollinators and seed-dispersing organisms is an important and crucial functional linkage in tropical forests. Elimination of certain tree species through selective logging can lead to loses in animal species closely or obligately tied to the trees (e.g. Terborgh, 1989). The forests of South America and Asia maintain very high animal species richness compared to the African tropical forests (UNEP, 1995). The rivers of the Amazon Basin host the most diverse fish populations present in its canopy also have high species richness (WCMC, 1999). Wilson (1992) recorded 43 species of ants, belonging to 26 genera, on a single tree in Peru, about the same number of species as the entire ant fauna of the British Isle. It is not unusual for a square kilometer of forest in Central or South America to contain several hundred species of birds and many thousands of species of butterflies, beetles and other insects (Wilson, 1992). Stattersfield *et al*. (1998) noted that of the total world forest avifauna, 88% are endemic to tropical forests, and of those, more than half are found in wet forest types.

Large numbers of species is endangered in tropical areas, despite incomplete taxonomy. The IUCN (2000) Red list reports that the majority of threatened species are often from tropical areas, and that high levels of species endangerment occurs in southeastern Asia (Malaysia 805 species, Indonesia 763 species, Philippines 387 species). Further, other small tropical states have high proportions of their species endangered, for example Cuba (206 species), Jamaica (240 species), Madagascar (302 species), and Papua/New Guinea (263 species). High numbers of endangered species are listed for some countries with large areas of tropical forest including Brazil (608 species) and Mexico (418 species).

2.2 CAUSES OF FOREST BIOLOGICAL DIVERSITY LOSS

2.2.1 Threats to biological diversity

It is important to distinguish between underlying or ultimate causes for loss of forest biodiversity from the direct causes. The underlying (or ultimate) causes of forest destruction are the factors that motivate humans to degrade or destroy forests; complex causal chains are usually involved. The underlying causes originate in some of the most basic social, economical, political, cultural and historical features of society. They can be local, national, regional or global, transmitting their effects through economic or political actions such as trade or incentive measures (WWF, 1998). The direct (or proximate) causes of biodiversity loss in forests are human induced actions that directly destroy the forests (such as conversion of forest land, continuous overexploitation or large scale logging) or reduce their quality (by, for instance, unsustainable forest management or pollution).

The driving forces behind direct human impact on forest degradation and deforestation and, consequently, on biodiversity loss are both numerous and interdependent (e.g., McNeely *et al.*, 1995; Contreras-Hermosilla, 2000; Hoffman et.al 2010). Forest biodiversity is directly linked to the existence of forest and to the way forests are managed, and that deforestation and forest degradation including unsustainable logging, slash and burn agriculture, the building of infrastructure such as dams and roads, pollution, fires, infestation, and effects of invasive species are themselves the main proximate causes for loss of forest biodiversity. Some of these proximate causes, such as climate change or agricultural development, can also act as underlying causes, (Benton, 1996).

The interactions between direct and underlying causes are very complex: the cause-effect relationships will vary considerably from country to country and/or over time and there can therefore be no overall hierarchy between the causes; they do not interact linearly, but rather in a circular fashion with many feedback loops. Even a single force such as agricultural intensification, may operate in a very different way under one set of circumstances than it would in a different situation with other variables involved. Accordingly, remedial measures need to be tailored to the very specific situation to which they will be applied. There are no simple solutions to this complex phenomenon. (Sunderlin and Resosudarmo,1999).

The distinction between direct and underlying causes of forest degradation is often not as clear as it appears. In reality, there are long, complex causation chains that eventually lead to deforestation. Causes may be hierarchical. For example, a hypothetical chain of causes and effects may operate in this way: shifting cultivators deforest because they need to provide a means of survival for their families. This is because they are poor and have few alternatives to deforestation. They are poor because present power structures discriminate against a large number of people who therefore have little or no means of survival. Present power structures originated in historical arrangements such as colonization and runs through unequal control over key resources, to poverty and the need to survive and finally, to forest decline.

Causal factors are likely to vary over time, sometimes drastically. At certain stages of development, rapid income growth could promote decline by, for example, increasing demand for forest products and by enhancing human capacity to alter forests. When economies reach a certain threshold, the process is reversed. At this point, increases in the level of income per capita begin to be associated with factors such as technological improvements, better functioning of government institutions, urbanisation and less relative dependence on agricultural and forest production. That leads also a change in the composition of demand for goods and services with greater demand for environmental services of forests and for uses, such as recreation, that do not necessarily lead to the loss of forest cover (Contreras-Hermosilla, 2000).

2.2.2 Lack of capacity, technical and financial resources

Despite all the efforts of donors to provide money and technology necessary to help conserve and sustainable manage forests, the lack of technical expertise and financial resources remains an important cause of forest decline. Understaffed forest authorities, lack of knowledge about forest biological diversity and related goods and services and the lack available qualified personnel lead to little or no application or enforcement of forestry laws. Gabon, for example, only 100 agents were available to monitor and inspect 322 logging concessions covering 86,00Km^2 (Global Forest watch, 2000). Another underlying cause for poor forest management is the lack of appropriate forest management plan and their implementation. Again in Gabon, only five of 200 logging companies have initiated work on a management plan (Global Forest Watch, 2000).

2.2.3 Lack of secure land tenure and land rights and uneven distribution of ownership

The lack of secure land tenure and the inadequate recognition of the rights and needs of forest-dependent indigenous and local communities have also been recognised as major underlying causes of forest decline (UN Econ. And Soc. Coun., 2000). Weak property rights reduce the incentive for sustainably managing the forests and unsecured land tenure is often directly related to deforestation. Local communities and indigenous people have, in many cases, traditional ways of sustainably managing the forests, ensuring that they remain viable for use by future generations. Increasing inequality of land ownership often leads to the breakdown of such common property management schemes. The rapid depletion of species and destruction of habitats occur in many countries where a minority of the population may own or control most of the land. Quick profits from excessive logging can flow to a small group of people, while the forest dependent local communities pay the price. Clear ownership rights are one of the prerequisites for developing sustainable management plans and applying regulations for ensuring the conservation and sustainable management of forests. Forest land often has a smaller value than agricultural land and, in the absence of laws that forbid deforestation; it is, therefore, cleared following privatization. On the other hand, privatization can be a prerequisite for ensuring sufficient investments in order to ensure the sustainable management of the forest.

It is well established that the existence of complete, exclusive, enforced and transferable property rights is a prerequisite for the efficient management of natural resources. Rights must be complete and exclusive to avoid disputes over boundaries and access. They must be enforceable to prevent others from usurping them and they must be transferable (there must be customary or full market in them) to ensure that land is allocated to its best use. The effects of incomplete or no property rights show up most clearly in the lack of incentive to invest in conservation and sustainable land uses. Regardless of the 'paper' designation of forest land rights, many forests are *de facto* open access resources i.e. resources for which there are no owner. Other forests are common property and are managed by a defined group of households with rules and regulations about access, use and transferability. Provided common property resources are not subject to external forces that lead to the breakdown of the communal rules of self-management, common property is a reliable and reasonably efficient use of forest land. Factors causing common property breakdown include rapid population growth and interference in traditional communal management by central authorities. Traditional, customary and, sometimes, even legally recognized land rights of indigene nous peoples can be hard to establish and are often ignored or violated.

Establishing property rights in the form of communal or private ownership regimes is a prerequisite to efficient land use, but may still not guarantee the desirable level of forest protection. This will be the case where the forest values take the fore of 'public goods' i.e.

services and goods the benefits of which accrue to a wide community of stakeholders and for which no mechanism exists to charge them for the benefits. Forest dwellers may then have no incentive to conserve forests for their benefits to downstream fisheries or water users, since they receive no benefit for these services. Institutional change designed to compensate forest users for these services can often be devised (see below), effectively establishing property rights in the unappropriated benefits of forest services.

Examples of policy failures that may lead to forest decline

Direct government investment in the forest sector or in related sectors	***Road construction** ***Hydropower investments**
Government command and control regulations	*Conservation area protection *Obligation to replant harvested areas *Prohibition to harvest without permit *Obligation to prepare forest management plans as condition for intervening in forest areas log export bans
Fiscal, price or monetary policies	*Subsidies affecting forest raw materials or other inputs *Subsidies affecting competitive uses of lands such as cattle ranching *Plantation subsidies *Price controls *Subsidies affecting forest harvesting or manufacturing *Price controls *Forest products taxes *Foreign exchange policies affecting competitive uses of lands
Provision of services	*Delimitation, demarcation and land titling *Actions to promote exports *Settlement of frontier areas

Source: (Sunderlin and Resosudarmo, 1999)

2.2.4 Lack of good governance

The lack of good governance, rampant corruption and fraud are major underlying causes of forest decline as they surround illegal logging and other related crimes, such as arson and poaching. Politicians and civil servant may misuse the public power entrusted to them by, for instance, sale of logging concessions for personal enrichment, by not enforcing laws and regulations and by partaking in other illegal and corrupt activities. This generally weakens the administrative apparatus, deprives the government of income, generate incentives for 'cut and run' logging operations and increases investment risks, thereby reducing incentives for sustainable forest management. The consequence in terms of forest biological loss and loss of related goods and services is often dramatic.

2.2.5 Ill-defined regulatory mechanism and lack of law enforcement

In some countries, the rise of corporate power has gone hand in hand with a breakdown in the rule of law. Economic hardship and a growing underclass have combined to create a rapid increase in illegal activity, including illegal logging, animal poaching and illegal trade. Lack of law enforcement is also linked to the lack of adequate financial resources allocated to the implementation of the regulations. Many national laws are too weak to provide adequate controls and when this is not the case, governments are often too weak to implement these. Property rights are more likely to be granted to those who clear the forests or live in the cities than to forest dwellers living by the sustainable harvest of natural products (Arnold and Bird, 1999). This favours extraction of marketable products (e.g. timber) over the sustainable harvesting of products with a limited market value. The range of ill-defined regulations can cover all aspects of the causes of forest decline. As an example, in some countries there are governments guidelines used to promote forest management activities that are detrimental to forest biodiversity. For instance, regulations of the former Latvian government for the management of cultivated forest areas required that every piece of dead wood be remove.

2.2.6 Illegal logging

A number of recent publications have revealed the extent of the wide range of illegal activities to be one of the major causes of forest decline (Jepson *et al*., 2001, FOE, 2000, Glastra, 1999, de Bohan *et al*., 1996). In the 1980s, the Philippines lost about US$1.6 billion per year, a large share of the country's gross domestic product, to illegal logging. In 1993, Malaysian log exports to Japan were under-declared by as much as 40%. Up to one-third of the volume of timber harvested in Ghana may be illegal and observers indicate that money injected into the country as part of a SAP led to illegal practices on a massive scale (Contreras-Hoermosilla, 2000). An internal report by the Cameroon Ministry of Environment and Forests (MINEF, 1999; see also FERN, 2001) provides clear evidence of large scale, illegal activities by logging companies in Cameroon. Six companies that are amongst the largest loggers of Cameroon forests are said not to respect basic requirements of sustainable forest management. For example, they do not prepare management plans and have no respect for environmental laws.

In Indonesia, illegal logging has been recognised as the most important cause of forest decline, about half to two thirds (30 – 50 million M^3) of wood consumed each year comes from illegal sources. It is exacerbated by bad governance and corruption, which often include the direct involvement of military, police and forest officials (Forest Liaison Bureau, 2000). If the current rate of deforestation continues in Indonesia, the lowland forest of the Sunda Shelf, some of the richest forests on earth, will be completely degraded by 2005 on Sumatra, and by 2010 in Kalimantan (Jepson et al., 2001). Global Witness (1998) described the scale of corrupt forest activities in Cambodia and stated that in 1997 much of the estimated US$184 million worth of timber felled in the country went into the pockets of corrupt officials. Illegal logging could mean the complete disappearance of Cambodia's forests in only five years time. All these studies strongly suggest a close link between illegal and corrupt activities on one hand and forest decline on the other. Greenpeace launched a series of press releases that provide evidence of the import of illegally logged wood products into the United States, Japan and European countries. According to one of their studies (Greenpeace, 2000), 80% of all wood logged in the Amazon is taken illegally.

The forestry sectors of tropical countries are particularly susceptible to illegal operations and corruption. There are several reasons for this:

(a) In most tropical countries, forest activities take place in remote areas, away from the press, the public and official scrutiny.

(b) Wood, particularly in tropical countries, is valuable but not inventoried. It is thus difficult to determine how much wood is illegally extracted.

(c) Frequently, officials have substantial discretionary power. High timber values and high discretionary power held by poorly paid government officials are ideal conditions for corruption (Contreras-Hersoilla, 2000).

(d) Investment in enforcement is minimal owing to other priorities.

Illegal logging is not limited to tropical countries but also occurs in other countries facing political and/or economic changes such as the Russian Federation, where an unknown, but probably substantial amount of timber is illegally logged and traded and exported, mainly to Chinese and Japanese markets but also to western Europe (FOE, 2000).

2.2.7 Lack of scientific knowledge and inadequate use of local knowledge

In many cases there is an inadequate knowledge of natural ecosystems (their components, structure and functioning). Furthermore, destruction and decline of cultures that possess a traditional understanding of nature is resulting in a permanent loss of important complementary information on ecosystems. These gaps in knowledge arise from an insufficient research effort in the study and monitoring of forest ecosystems. Such research is necessary in order to improve understanding of how various components interact, to improve information on traditional use and knowledge of biodiversity and to implement appropriate changes in ecosystem use.

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2.2.8 Under –valuation of forest biological diversity goods and services

Many forest products are consumed directly and never enter markets. For instance, sawn timber, pulpwood, rattan and gums may be marketed, while food, fuelwood and medicinal plants harvested by local people will usually be consumed directly by them. Biodiversity benefits are in large part “public goods” that no single owner can claim. The benefits of biodiversity are so diffuse that no market incentives for biodiversity conservation ever develop, which 'justifies' government policies that further encourage conversion of the forest to other use with greater direct market values. Thus biodiversity will probably continue to decline while it remains undervalued or not valued. A challenge is to develop ready means of attaching greater value to it in order to provide an incentive for sustainable management.

One of the features underlying comparisons of relative profitability of different forest land uses is the role of the discount rate. High discount rates favour conventional logging over sustainable timber management, slash-and-burn agriculture over agro-forestry and so on. The issue is therefore one of knowing how large discount rates are in such contexts. Existing research suggests that local communities often have high discount rates of well over 10% and up to 30 or 40%, reflecting their urgent need to address subsistence and security needs now rather than in the future (Poulos and Whittington, 1999). While this conclusion should not be exaggerated – there are many examples of poor communities investing in conservation practices – the available evidence supports the traditional view that many have high discount rates that these contribute to 'resources mining'.

2.2.9 Lack of cultural identity and spiritual values

As cultural homogenization sweeps across the world, the vast range of human knowledge, skills, beliefs and responses to biological diversity is eroded, leading to great impoverishment in the fund of human intellectual resources. Loss of cultural diversity, as a result of globilisation, leads to loss of biological diversity by diminishing the variety of approaches to the coexistence of humans, other animals and plants that have been successful in the past. Loss of the different cultures also reduces the possibility of imaginative new approaches being developed in the future.

2.2.10 Deficiencies in the flow of information in decision makers and to local communities

Where scientific or traditional knowledge exits, it does not necessarily flow efficiently to decision-makers, who may in consequence often fail to develop policies that reflect the full values of biodiversity. Information also fails to flow efficiently between central decision-makers and local communities. To complicate things further, there is a strong public reluctance to accept policies that reduce excessive resource consumption, no matter how logical or necessary such policies may be.

2.2.13 Lack of Environmental Impact Assessments or Strategic Environmental Assessments

Infrastructure development projects, structural adjustment programmes, development programmes and trade agreements have been identified as possible direct and underlying causes of forest biodiversity loss. The problem is exacerbated by the fact that very often no Environmental Impact Assessment (EIA) or Strategic Environmental Assessment (SEA) accompanies the development of these projects. In addition, many EIAs or SEAs that are undertaken do not include a concrete analysis of the impact of the projects on the quality, size and management of the forests that may be affected.

Consequences of forest biodiversity loss from the perspectives of different segments of society

Societal Group	*Implications of continued Forest Biodiversity loss*
Forest-dwelling indigenous communities	*Loss of spiritual values. *Disruption of traditional structures and communities, breakdown of family values, and social hardship. *Loss of traditional knowledge of use and protection of forests in sustainable ways. *Reduced prospects for preservation of forest environmental and aesthetic functions of interest and potential benefit to society as a whole. *Loss of forest products providing food, medicine, fuel and building materials.
Forest farmers and shifting cultivators	*For shifting cultivators, an immediate opportunity to survive *Forest deregulation and declining soil fertility *Loss of access to forest land and the possibility of food crop production and reduced possibility for harvesting forest products, both for subsistence and income generation. *Prospects of malnutrition or starvation. *Disruption of family structures and considerable social hardship.
Poor and landless local communities living outside forests	*Decreased availability of essential fruits, fuelwood, fodder and other forest products. *Reduced agricultural productivity, through loss of the soil and water protection potential of remnant woodlands and on-farm trees and loss of shelterbelt influence leading to reduced crop yield. *Reduced income generation and possibilities to escape poverty.
Urban dwellers	*In developing-country situations, reduced availability (and /or overpriced) of essential forest products such as fuelwood, charcoal, fruits, building materials and medicinal products. *Loss of the amenity and recreational values of urban forests and parks and those afforded by national forest parks and wilderness areas. *Reduced prospects for assured supplies of clean drinking water and clean air.
Commercial forest industries and forest worker communities	*Immediate large profits. *In the long-term, loss of company business and forced closure of forest operations. *Loss of jobs for forest-dependent communities, social disruption and hardship. *Loss of income and possible negative social implications of reduced of shareholders with significant savings invested in forest industrial company

	stock.
Environmental Advocacy groups and conservation agencies	*Loss of the essential functions of forests, including biodiversity, climate regulation, preservation of water catchments and fishery values, that these groups are concerned with preserving. *Loss of cultural values and social hardship for the underprivileged communities whose welfare these groups are committed to protect. *Increased problems of environmental pollution *Loss of those forest values that could be of vital importance and/or interest to the survival and welfare of future generations.
Mining, oil exploration and other industrial interests	*Improved access to potentially profitable mineral, oil or other commercially valuable products located under forests. *Increased profitability of company operations and returns to company shareholders. *politically negative impact on company operations of criticism by environmentally concerned groups.
The global Community	*Prospects that continued forest destruction will accelerate global warming and potentially negative consequences for human welfare and survival. *Continuing biotic impoverishment of the planet, loss of genetic resources, and all that implies for sustainable food production and loss of potentially valuable medicinal and other products. *Increasing pollution and toxicity of forest soils, contributing to declining forest health.
National government and planners and decision makers	*Immediate escape from political pressures when impoverished populations migrate to frontier forest areas. *Loss of potential source of development revenues with consequences of reduced employment and opportunities, sustainable trade and economic development. *Loss of the wide range of environmental functions that forests provide in contributing to societal needs and an habitable earth. *Loss of political support in situations where forestry loss and degradation adversely affect the welfare of many citizens.

Source: (Sunderlin and Resosudarmo, 1999)

2.2.11 Perverse incentives and subsidies and ill-defined developmental programmes

Governments world-wide provide incentive systems that affect natural resource use. While usually conceived with good intentions, they often have deleterious effect on natural resources. Notable examples include the $800 billion spent each year on subsidizing certain economic activities, especially agriculture ($400 billion). Most subsidies are in the developed economies, where agricultural subsidies are responsible for some reduction in woodland area, the woodland being removed to capture the subsidies, which are often on a per hectare basis (Porter 1997, Pearce and von Finklestein 1999, Sizer, 2000). In some parts of the developing world subsidies exist for the clearance of forest land, and in some cases title to the land cannot be secured without a given percentage of the land being cleared (Porter, 1997). Other subsidies are more subtle, and may take the form of preferential logging concessions and low royalty relative to what could be charged without deterring logging companies. Low charges increase the 'rent' to be secured from the land. The result is a competition that uses up resources to no productive purpose. Ensuring a good share of rent can involve corrupt practices such as bribes to officials and politicians. In turn, this can result in more extensive logging outside 'official' concessions and more intensive logging inside concessions as those responsible for enforcement secure greater rewards from the bribes than they do from normal employment. Unsustainable logging is more immediately profitable and hence there is a financial incentive to override or ignore regulations designed to secure sustainable forest management. The extent of 'illegal' logging is not known with any accuracy but is clearly very large and may, in some countries, greatly exceed the officially declared rates of logging. Tackling illegal logging is immensely complex since it effectively involves tackling the corruption involved. Countervailing power in the form of NGOs and citizens' groups can help, an can a free media and international disapproval. Statistical studies suggest that political freedom may be linked to reduced deforestation, but the evidence is not firm (Kaimowitz and Angelsen, 1998). Overall, though, there are powerful incentives for illegal logging and deforestation generally (Porter 1997).

Many other sectoral governmental fiscal, monetary and other subsidies and incentives also create driving force for deforestation and forest degradation. For example, transportation policies often promote the construction of roads; agricultural policies tend to promote the conversion of forests into agricultural land; resettlement programmes are frequently detrimental to forest areas; and government subsidies promoting mining and hydrological infrastructure are often available. Those government incentives are regularly supported through ill-defined development aid projects. Furthermore, direct or indirect subsidies are given to economic forest operations that can damage biodiversity, such as the drainage of forests and the logging of old growth forests (Sizer and Plouvier, 2000). The more common and important type of subsidy in the forest sector is that implicit in the low forest charges paid by timber concessionaires. Although justified on the grounds of promoting local development and employment, they can sometimes lead to a "boom-and-bust" situation with consequent excessive and wasteful forest degradation (Contreras-Hermosilla, 2000), and poor forest regeneration.

2.2.12 Poverty

Poverty is both a consequence and an underlying cause of forest decline. The case of Haiti is just one of many examples showing how total deforestation, followed by soil erosion has deprived rural populations of their basis for livelihood (Paskett and Philoctete, 1990). Poverty often leads to deforestation and forest degradation. Poor people are frequently forced to slash and burn or otherwise degrade forests in response to population growth, economic marginalisation and environmental degradation. However, linkages between the rural poor and forest resources they draw upon are complex and poverty does not necessarily lead to forest decline. Many poor people are able to adopt protective mechanism through collective action which reduces the impacts of demographic, economic and environmental changes.

2.2.13 Population Change

Brown and Pearce (1994) reviewed the econometric studies that link deforestation rates to explanatory factors. They found that population growth is generally linked to deforestation, although the patterns of interaction are complex. However, though simple statements that ‘population growth causes deforestation’ are also unquestionably false, many models show that population change is important (Kaimowitz and Angelsen, 1998). As current population levels rise from 6 billion people to a predicted 9 billion in 2050, with much of the increase in tropical countries, pressures on forest areas must be expected grow. Lowland-upland migrations and officially induced transmigration will add to the pressure.

Another billion people are likely to be added to the world population for each of the next decades. This population increase will occur mainly in developing countries, creating a strong demand for agricultural lands, forest products and “forest crops” (cocoa, coffee, bananas, etc.) To meet the associated food demand, crop yields will need to increase consistently, by over 2% every year throughout this period (Walker and Steffen, 1997). While possible responses to the food supply issue may

The improvements in technology, better distribution of food purchasing possibilities, better nutritional education and health care, it is likely that most immediate response will be converting more forest ecosystems to agricultural land.

However, it is important to mention that the link between forest decline and population pressure remains unclear due to the complexity of the factors involved.

Most studies indicate a positive relationship between population and deforestation, but most analysts are almost very careful to indicate that there other factors that obscure this linkage. For example, many authors note that loggers first make forests accessible and then settlers occupy lands. If this is the case, then population density is the result of logging and associated initial deforestation or forest degradation, not the other way round. In addition, unless reliable information on the changes in forest cover is available, it is difficult to see the links clearly (Sunderlin and Resosudarmo, 1999). At the global level, it is obvious that the enormous and still increasing demand for forest resources (timber, paper, etc) by developed countries, which do not now face population growth, is another cause of forest loss.

2.2.14 Globilization

At present, a fifth of the world's population uses 85% of its resources. The globalisation of trade and these demands from developed world for paper, timber, minerals and energy provide the incentive to exploit natural resources in the developing world. The financial and political power of large companies adds dramatically to pressures in forest ecosystems that had previously been too remote to attract attention, such as some Central African's rainforests and the taiga in far-eastern Russia.

In addition, the global exchange economy is based on principle of comparative advantage and specialization and has increased in both uniformity and interdependence. In forest areas, the rapid and total conversion of forest into monocultural cash crops is widespread. But when the price of palm oil, coffee or cocoa drops, the plantation cannot quickly revert to the biologically diverse forest that proceeded it, even if when left alone. This is particularly the case where large-scale clearing has occurred, e.g. in south Sumatran oil palm plantations.

If environmental and social externalities (costs and benefits) are not internalized, then market prices do not reflect true social values, causing allocative inefficiency. Where externalities are not internalized, the increased economic growth from liberalised trade and investment will serve only to exacerbate, rather than address environmental problems, especially in those countries that depend on the export of natural resources – e.g. forest products. The liberilisation of exchange and trade policies can improve the terms for agriculture expansion and therefore promote the clearance of forest for agricultural crops. The solution is to correct market distortions through sound environmental and sustainable development policies and in addition, measures identified to ensure conservation and sustainable use of forest biological diversity must be implemented before bilateral and multilateral trade agreements.

International trade, investment, debt and technology transfer issues foster inequity between developed and developing countries that resemble or often reinforce those found within countries. For example, most export credit agencies and investment agencies, which finance numerous development projects, are not subject to environmental or social guidelines or standards that would ensure that they do not contribute to ecologically or socially harmful projects.

Another effect of globalisation is the increasing activity of transitional logging companies. These activities often result in an expansion of destructive logging operations, violation of indigenous rights and, sometimes, widespread corruption. Most of the new investment focuses on short-term activities and economic benefits to the exporting country are usually very low. In addition, the forests are often mined rather than managed, resulting in high levels of damage and increased access to previously untouched areas (Sizer and Plouvier, 2000).

2.2.15 Unsustainable production and consumption patters

Agenda 21 of the World Conservation Strategy notes that the major cause of the continued deterioration of the global environment is the unsustainable pattern of consumption and production, particularly in industrialised countries. It further notes that while consumption is very high in certain parts of the world, the basic consumer needs of a large section of humanity are not being met. Changing consumption patters towards sustainable development will require a multi-pronged strategy focusing on meeting basic needs and improving the quality of life, while reorienting consumer demands towards sustainably produced goods and services. Per capita consumption increased as real gross domestic product (GDP) grew at 2.9% per year while population growth was 1.4% per year. A closer look at economic trends, however, shows large disparities between and within regions. As noted in the UN Human Development Report (1998), 20% of the world's population, in the high-income countries, account for 86 per cent of total private consumption expenditures, while the poorest 20 per cent, in low-income countries, consume a mere 1.3%. Annual consumption per capita in industrialised countries has increased steadily at about 2.3% over the past 25 years, it has increased very rapidly in East Asia at around 6.1%, and at a rising rate in South Asia at around 2.0%. On the other hand, the consumption expenditure of the average African household is 20% less than it was 25 years ago (UN, 2001, Jachman, 2008). The effects of these consumption patterns on forest biodiversity need to be analyzed further.

As income rise, so the demand for natural resources increases. The relationship is a complex one, however. For some forest services, the income-demand relationship can be such that as incomes grow the demand for those services decreases. An example might be the switch from wood fuels to liquid fuels as incomes grow. At the global level, however, higher income countries do consume larger absolute amounts of raw materials. This has led to the view that deforestation is linked to excessive consumption in rich countries. The issue is complex because the efficiency of raw materials use, i.e. the ratio of raw materials to income, tends to be lower in richer countries than in poor countries. Rich countries utilize natural resources more efficiently, but the scale of their incomes means that the absolute level of consumption is higher than in poor countries. Since the aim of development is to raise per capita income, reducing that income is not a realistic policy option, nor is it clear what policies would bring this about without damaging the factors giving rise to income growth – education, technology etc. But it is legitimate to ask that rich countries greatly increase their use efficiency. This will then translate into reduced demand for raw materials, including forest products imported from developing countries. Care has to be taken that this does not damage the export potential of forested countries, but clearly there is scope for making this transition. Additionally, richer countries can afford to pay premiums on forest products to discriminate between sustainably managed products.(CBD, 2002)

2.2.16 Political unrest and war

One of the most important waves of large-scale forest destruction in Europe, occurring from the 15th to the 17th century, was due to the need for wood for military ship building. At the same time, dwindling wood resources for the navy prompted a number of forest protection, conservation, restoration and management measures in a number of European countries that present generation will benefit from. There is clear evidence that armed conflicts or political instabilities still correlate with an accelerated rate of forest destruction. Cambodia, Congo, Indonesia, Laos, Liberia and Sierra Leone are just a few of the countries where forest are logged for quick cash needed to purchase military weapons and where the authorities have lost control over natural resources enabling specific actors such as the army to deplete the forests, either illegally or legally. A recent report commissioned by the UN Security Council (2001) on illegal exploitation of natural resources and other forms of wealth in the Democratic Republic of Congo demonstrates that illegal logging is linked to armed conflicts and suggests concrete measures to reduce trade in so-called “conflict timber”. Forests are also being destroyed (e.g. by herbicides) in order to eradicate sheltering places for guerilla forces, as was common practice during the Vietnam war. In addition, armed conflicts cause increasing pressure on non-timber forest products, particularly bush meat for food for either the armed forces or populations that have been forced to move from conflict areas, such as in Central Africa. This places some already threatened species, e.g. gorilla, in a very dangerous situation. On the other hand, creating military security zones has in many areas left large areas outside economic activities. In future, many of these areas may be suitable for designation as protected areas.

2.2.17 Conversion of forests to agricultural land

The major causes of deforestation are the expansion of subsistence agriculture and large economic development programmes involving agriculture. The conversion of forests into agricultural land has been the major historical cause for deforestation in Europe, Asia, and North America and still is a major driving force today in the tropical and sub-tropical areas. The current agents vary from small farmers practicing shifting cultivation or clearing forests for subsistence needs to large agricultural concerns that clear vast tracts of forest lands in order to establish cattle ranches or agro-industrial plantations such as soya beans in Latin America and oil palm in Indonesia/Malaysia.(WRI *et al.*, 1992;WCMC, 1992; Stedman-Edwards, 1998; Thomas et al 2007).

2.2.18 Dismantling of agro-forestry system

An emerging and rather insidious threat to biological diversity and tree genetic resources is posed through the dismantling of agro-forestry systems, i.e. the removal or failure to plant trees in agricultural and horticultural systems. This is usually associated with intensified, often monocultural, agricultural and livestock husbandry practices that eliminate trees from rural and urban agricultural areas. In Tonga, especially on Tongatapu, successive phases of unsustainable cash cropping have led to the elimination of trees in agro-ecosystems. In parts of Africa many useful tree species now as exists only as scattered individuals or highly fragmented non-viable populations in agro-ecosystems, and are likely to disappear within the next few decades (IUCN, 2000). Tress in agro-ecosystems may disappear either directly through cutting and clearing, or through establishment for regeneration and recruitment of remnant tree species.

2.2.20 Overgrazing

Overgrazing is increasingly a major threat to biodiversity in both tropical and temperate forests. The main impacts are damage to the topsoil, destruction of understory vegetation and/or replacement with a narrower range of unpalatable species and selective browsing of regenerating tree species, which may eventually result in the elimination of particular species.(CBD, 2002).

2.2.21 Natural Hazards and Forest Fires

Natural hazards, such as storms and hurricane damage, forest fires, floods and pests are natural disturbance regimes in forests. They can often have a positive impact on biological diversity. These disturbances, on a small or large scale, can create specific habitats that are important for the survival of a plethora of flora and fauna; they should therefore, be mimicked or maintained in forest management (Angelstam, 1998). However, many human induced activities exacerbate these disturbances in a way that makes them an increasing threat to forest biodiversity.

Natural fires are a crucial element for the succession of many forests, especially in boreal areas. Prescribed burning, mimicking wildfires should be used to a greater extent in restoration of forests in conservation areas and also in some managed forests. With a changing climate, however, natural and human-caused fires can have deleterious impacts on forest biological diversity; for instance, after the predicted prolonged periods of drought. These fires have destroyed many important fire refugia on which many forest species intolerant to fire are dependent. Both the unusual frequency and new regional occurrence of fires may be attributed to climate change.

Lack of fire in habitats where fire is part of the ecological process of regeneration (e.g. savannah woodlands or boreal forests) can have a deleterious effect on biological diversity and its processes in the longer term. However, extreme climatic events generating fire can have devastating impacts on forest biological diversity. For example, a prolonged or abnormally severe drought can be followed by uncontrolled fire, which can destroy sensitive forest communities and species. In recent decade forest fires have been particularly severe and very widespread (in, for instance, Australia, Brazil, Central America, Colombia, Indonesia, Kenya, Mexico, Mongolia, Papua New Guinea, Peru, Russia, Rwanda, Spain, USA and western Canada). Fires devastated large forest areas that normally do not get burnt. Such unprecedented frequency and unusual occurrences of fires may be attributed to climate change. Fragmentation may prevent or inhibit recolonisation of burnt forest patches by fire-sensitive animal and plant species, thereby aggravating the negative impacts of increased fire frequency and intensity on forest biological diversity. In Samoa, two severe tropical cyclones in the early 1990s ravaged the remaining lowland rainforests, which had been opened up to greater destruction through heavy logging. These "secondary" forests are now in a state of arrested regeneration, mostly smothered by the rampant native climber (*Merremia peltata*) and increasingly subject to periodic wildfires during El Nino drought years. Merremia has also become a problem in the Solomon Islands and Malaysia following both fire and logging (Bacon 1982, Pinard and Ptuz 1994). This example illustrates the point that forest biological diversity is especially vulnerable to the interactions of multiple threat factors.

2.2.22 Actions and priorities for conservation and sustainable use of biodiversity

The necessity of ensuring that utilization of an ecosystem or species is sustainable varies with a society's dependence on the resource in question. For a subsistence society, sustainable utilization of most, if not all, its living resources is essential. The greater the diversity and flexibility of the economy, the less the need to utilize certain resources sustainably – but by the same token the less excuse not to. Sustainable utilization is also necessary for the rational planning and management of industries dependent on the resources concerned (for example, timber, fish). Sustainable utilization is somewhat analogous to spending the interest while keeping the capital. A society that insists that all utilization of living resources be sustainable ensures that it will benefit from those resources virtually indefinitely. Unfortunately, most utilization aquatic animals, of wild plants and animals of the land, of forests and of grazing lands is not sustainable. According to Convention on Biological Diversity (2002), actions for improvement of conservation and sustainable utilization of biodiversity are grouped under the following headings:

(a) Assessment and monitoring

(b) Conservation and sustainable use

(c) Institutional and socio-economic enabling environment.

2.2.23 Assessment and monitoring

Biological diversity is a scaled consideration, ranging from genes of individual organisms, to large forest landscapes, to global biological diversity. Therefore, classification, monitoring and reporting must occur on all scales and must involve all stakeholders (in particular the indigenous and local forest communities and not only the scientific community in proper contexts.

2.2.24 Conservation and sustainable use

Conservation and, where appropriate, enhancement of forest biological diversity should be an important aspect of conservation and sustainable use of all types of forests. This applies to the whole range of forest categories, from protected primary forests, secondary forests, plantations, agro-forests to other ecosystems that include elements of forest biological diversity.

The development and implementation of the ecosystem approach, as described in decision V/6 of the conference of the Parties, should be guiding principle to achieve the conservation and sustainable use of forest biological diversity and it should be applied to the full continuum of forests, from protected areas to plantations. Application of the ecosystem approach to forest management should be based on both science and adaptive experience.

Critical levels of biological diversity loss/change that affect forest ecosystem functioning, and, in turn, the goods and services provided by forests are still largely unknown among forest types. This uncertainty emphasizes the value of applying the precautionary approach. As stated in the Preamble of the Convention on biological Diversity, lack of full certainty should not be used as a reason for postponing measures to avoid or minimize the threat of significant reduction or loss of biological diversity.

2.2.25 Institutional and socio-economic enabling environment

To identify and propose measures to halt and reverse global forest biological diversity loss, both the direct and underlying causes of forest decline must be addressed. Political and economic decisions taken in forestry and other forest-related sectors should safeguard forest biological diversity and result in a fair distribution of associated costs and benefits among resource users.

Creating an enabling legal, policy, economic, and institutional environment to address the causes of forest biological diversity loss is a fundamental and urgent prerequisite for the conservation and sustainable use of forest biological diversity. The Convention on Biological Diversity should place increased emphasis on this matter in its work programme, and each country should engage in a process to establish an enabling environment that is conducive to the conservation and sustainable management of forest biological diversity. The process should be specific to the country, the land-use and context. Key actions necessary to establish such an enabling environment can be summarized as follows: (a) increase political will; (b) provide adequate institutional, human and financial resources; (c) ensure adequate involvement all stages of indigenous peoples and local communities in forest management; (d) ensure integration of forest biological diversity conservation and sustainable use into all relevant sectors; (e) secure a permanent forest estate and an adequate land tenure and forest use system; (f) provide a national and global economic environment conducive to the conservation and sustainable use of forest biological diversity; and (g) establish and enforce appropriate legislation.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 THE STUDY AREA

The study area is contained in the 9,700 hectare land of the University of Agriculture, Abeokuta, situated north-eastern of Abeokuta, along Alabata road, (fig.1). The site is located between latitude 7^{o} and 7^{o} $58^{!}$ And Longitude 3^{o} $3^{!}$ And 3^{o} $37^{!}$ Generally, the site gently undulating with mild slopes but punctuated in part by ridges, isolated residual hills, valleys and lowlands, all of which present a good landscape for aesthetics.

There is a general drop in elevation from the eastern to the western part towards Ogun river flood plain where the seasonal stream network within the sitew empties their content. Six soil series have been identified in the area. These are Egbeda series (Oxic paleudults), Asejire series (typic psammaquent), Iregun series (Oxic ustropept),

Balogun series (Psamentic Hapludults), and Iwo series (Oxic paleudalts). The soil are mainly sandy to sandy loam with medium depth underlain by crystalline basement complex. The soils have low to moderate organic matter and essential nutrients (Anon, 1992).

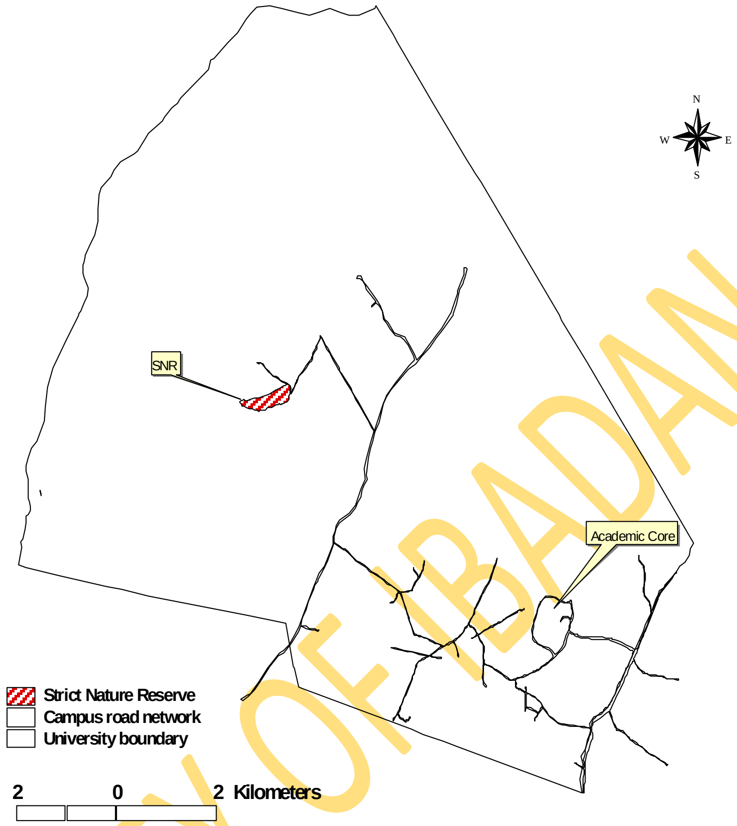

Fig. 1: Map Of the University of Agriculture showing the Study Area.

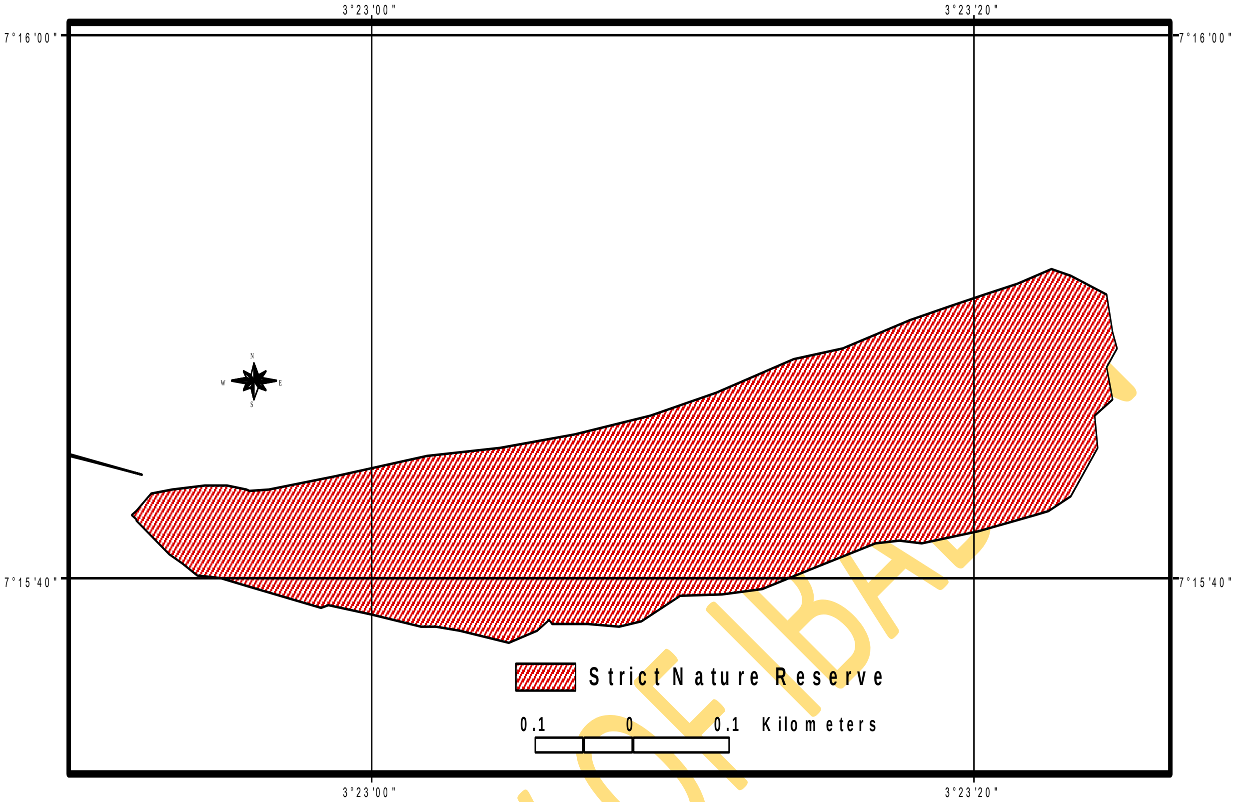

Fig. 2: Map of Study Area.

3.1.1 LAND USE HISTORY

Before the acquisition of the land by the University in 1998, the most extensive land use was arable farming. Other land uses included quarrying for sandstone. Consequently, with the acquisition of the site, farming activities have decreased considerably. Nevertheless, the following agricultural crops still doted the site, maize, cassava, pepper, poorly maintained cocoa, citrus, cashew, banana and plantain.

3.1.2 VEGETATION

The area comprises of various vegetation types ranging from a large portion of derived savanna, secondary rain forest and riparian types. The derived savanna is climatically similar to rainforest zone, but a combination of farming, lumbering and burning have resulted in clearings in the forest which have been colonized by grasses and fire resistant savanna trees. The grasses are burnt annually so that clearings are maintained and the rainforest trees, which are susceptible to fire, cannot re-establish. This has encouraged the spread of derived savanna. Relics of former rainforest occur along some river valleys and in localities unsuitable for cultivation. The commonest species of trees in the area are:- *Daniella oliverii, Cussonia barteri, Annogeissus leiocarpus, Pterocarpus spp, Ficus exaspirata, Ficus thonningii, Bambusa vulgaris, Afzelia africana, Annona senegalensis, Anarcardium occidentale, Bridelia micrantha, Bridelia ferruginea*, etc

The common grasses belong to the general *Andropogon, Hyparrhenia* and Pennisetum. The grasses include:- *Andropogon gayanus, Andropogon tectorum, Pennisetum spp, Paspalum nonantum, Impereta cylindrical, Panicum maximum*, etc, while the shrubs include:- *chromoliana odorata*, *Aspilia Africana*, *Commelina nudiflora*, *Waltheria spp*, etc.

3.1.3 CLIMATE

The site falls within the humid tropical lowland region with two distinct seasons. The longer wet season lasts for eight (8) months, from March – October and the shorter dry season lasts for four (4) months from November – February. The area normally witness high rainfall at two periods of the year, i.e the peak period of June – July and September – October. It has a mean annual rainfall of 1250 to 2500mm.

The mean monthly temperature ranges between 25.7oC in July and 30.2oC in February. The lowest temperature is recorded in June and September. The relative humidity is high all year round. The most humid months coincides with the rainy season, spanning between March and October and the figure ranges between 60% and 80% from December to February.. Fig 2 shows the climatic diagram and temperature pattern in the study site.

3.2 SAMPLING PROCEDURES

Twenty (20) sample plots of 25m x 25m (0.062ha) were laid at random over the total area of the study site for data collection. The plots were distributed according to the observed richness in vegetation cover. For accuracy and ease in data collection, each plot of 25m x 25m was partitioned into 5 quadrates of equal sizes at the left and right sides of the centerline of each plot.

3.2.1 Data Collection

The importance of reliable and adequate data collection for policy formulation and planning for the purpose of sustainable use and biodiversity conservation cannot be over emphasized (Ojo, 1996). The collection of data was based on these categorization:- plants and animal surveys.

3.2.2 Vegetation Survey

The vegetation survey was divided into two types :

(a) the tree and shrub enumeration

(b) ground flora enumeration

(a) Tree and Shrub Enumeration:- Total enumeration would be carried out in each sample plot for all the trees and shrubs. A tree is taken to be any vascular stem with a girth of $\geq$ 5cm and does not fork before 1.3m mark. All the measurements to be taken are indicated below:-

Diameter at breast height of trees

Height of trees at first branch (Marchantable height)

Total height of trees

The diameter at breast height was taken using girthing tape while the height was measured by Spiegel relascope. These provided the floristic data for the study. The specimens that cannot be identified on the field were taken to a standard herbarium for proper identification.

(b) Ground Flora Inventory:- All ground flora with height below 1m and dbh of $\leq$ 5cm were enumerated for their percentage abundance in each plot.

3.3 ANIMAL (VERTEBRATES) SURVEY

King Census and Line Transect methods were modified fo this study using direct and indirect modes of wildlife stock assessment for an accurate collection of data due to the dense nature of the vegetation in some areas.

Direct count method was used for all animals sighted during the laying of plots.

Animal survey was carried out within the plots and a checklist of all animal species found in the study area was made.

The indirect method of sampling was also used. All indicators of animal presence or activities in the plots sampled were recorded. The signs or indicators used for assessing the presence of animals include:

a. Animal droppings
b. Call counts
c. Nest counts
d. Body parts dropping (e.g. feathers, hairs)
e. Dens and Burrows
f. Tracks and trails
g. Foot print
h. Feeding remnants

3.4: SOIL SURVEY

Soil samples at 0 – 15cm, 15 – 30cm, and 30 – 45 cm depths was collected for each plot. This was done randomly at three points at the centre line for each plot and the sample from each depth was bulked together and air-dried and analyzed for pH, organic carbon, nitrogen and the particle size distribution using standard methods.

3.5: HUMAN INTERFERENCE

Structured questionnaire were administered randomly to 20 individuals in 4 farm settlements (five in each settlement) close to the study area to assess the level of human interference.

3.6: CLIMATIC DATA

Information on climate for the study period; 2006 – 2008 was obtained from the Department of Agricultural Meteorology and Water Resources Management of the University of Agriculture, Abeokuta.

3.7: METHODS FOR DATA ANALYSIS

The materials of biodiversity data collection and analysis are as diverse as the types collected. In this study, the indices discussed bellow was used in determining plant and animal diversity in the study area.

- Biodiversity Determination
- Simpson's diversity index
- $\sum_{i=1}^{s} \frac{ni\ (ni - 1)}{N\ (N - 1)}$

ni is the number of individual of specie i which are counted and N is the total of all individuals counted

Shannon's diversity index

$$H = \sum_{i=1}^{s} pi \ln pi$$

Pi is the fraction of individuals belonging to the i-th species

CANOCO program after Ter Braak (1998) was be used for analysis of plant and animal species and soil data. The floristic gradient of the study site was explored with

Detrended Correspondence Analysis. The purpose of using ordination is to explore possible gradients and association between soil/site and interacting species in the area. In addition an important use of ordination technique is to arrange the interacting species and sites in such a way that similar plant species or animals are arranged far apart. The data generated after the analysis was used to plot ordination diagram for generating hypothesis about the relationship between community composition and the environmental factors that determine such association (Greing-Smith, 1983).

CHAPTER FOUR

4.0 RESULTS

4.1 PLANT FREQUENCY DISTRIBUTION AND RELATIVE ABUNDANCE

The plant average frequency of plants in the study area is shown in table 2. One hundred and eighteen (118) plant species belonging to forty – four (44) families were enumerated. The most abundant tree species were *Daniella oliveri*, *Anona selegalensis*, *Bradelia micrantha* and *Ficus capensis* in that order. The commonest ground flora recorded were *Andropogon tectorum*, *Andropogon gayanus*, *Chromolaina odorata* and *Aspilia africana*.

Table:1 Scintific Names and Codes of Plants in the Study Site

Couplet No	*Scientific Name*	*Code*
1	*Abelmoschus esculentus*	ABES
2	*Abrus precatorius*	ABPR
3	*Abutilon*	ABMA
4	*Acacia kamerunesis*	ACKA
5	*Acacia sieberina*	ACSI
6	*Acalyphyta ciliate*	ACCI
7	*Acanthospermum hispidum*	ACHI
8	*Acanthus montanus*	ACMO
9	*Achyranthes aspera*	ACAS
10	*Acridocarpus smeathhniamii*	ACSM
11	*Adansonia digitata*	ADDI
12	*Adenopus brevflorus*	ADBR
13	*Afromorsia laxiflora*	AFLA
14	*Afzelia Africana*	AFAF
15	*Agelea oblique*	AGOB
16	*Agerantum conysoides*	AGCO
17	*Albizia adianthifolia*	ALAD
18	*Albizia coriara*	ALCO
19	*Albizia feruginea*	ALFE
20	*Albizia zygia*	ALZY
21	*Albizia lebbeck*	ALLE
22	*Alchornea cordifolia*	ALCD
23	*Alchornea laxiflora*	ALLA
24	*Allophyllus africanus*	ALAF

25	*Alstonia boonei*	ALBO
26	*Alstonia congensis*	ALCG
27	*Amaranthus spinosus*	AMSP
28	*Amaranthus hybridis*	AMHY
29	*Anarcardium occidentate*	ANOC
30	*Ananas comosus*	ANCO
31	*Aneilema beniniense*	ANBE
32	*Anchomamis difformis*	ANDI
33	*Ancistrocapus densisipinosus*	ANDE
34	*Andropogen gayanus*	ANGA
35	*Andropogen teetorum*	ANTE
36	*Anogeisus leiocarpus*	ANLE
37	*Anona senegalensis*	ANSE
38	*Antana Africana*	ANAC
39	*Anthocleista vogeillii*	ANVO
40	*Anthocleista djalonesis*	ANDJ
41	*Anthonotha macrophylla*	ANMA
42	*Anthephora ampilliaceae*	ANAM
43	*Antiaris Africana*	ANAF
44	*Antiaris toxicaria*	ANTO
45	*Asparagus flagellaris*	ASFL
46	*Aspillia Africana*	ASAF
47	*Aspillia busei*	ASBU
48	*Asystatsia gangetica*	ASGA
49	*Azadirachta indica*	AZIN
50	*Axonopus compressus*	AXCO
51	*Bambussa vulgaris*	BAVU
52	*Bidens pilosa*	BIPI
53	*Blepharis maderoapatensis*	BLMA
54	*Blighia sapida*	BLSA
55	*Blighia welwetehii*	BLWE
56	*Boerharia coccinea*	BODI
57	*Boerharia deflexa*	BOCO

58	*Bombax buanopozense*	BOBU
59	*Brachiera deflexa*	BRDE
60	*Brachystegia eurycoma*	BREU
61	*Bridelia feruginea*	BRFE
62	*Bridelia micrantha*	BRMI
63	*Burkea Africana*	BUAF
64	*Cajanus cajan*	CACA
65	*Calotropis procera*	CAPR
66	*Canavalium ensiformis*	CAEN
67	*Canhium vulgera*	CAVU
68	*Carica papaya*	CAPA
69	*Carpolobea lutea*	CALU
70	*Cassia alata*	CAAL
71	*Cassia monosoides*	CAMI
72	*Cassia podocarpa*	CAPO
73	*Cassia siamea*	CASI
74	*Ceiba pentadra*	CEPE
75	*Celosia argentea*	CEAR
76	*Celtis zenkeri*	CEZE
77	*Centrocema puebescens*	CEPU
78	*Chamaecrista mimosoides*	CHMI
79	*Chloris pilosa*	CHPO
80	*Chassalia kolly*	CHKO
81	*Chrosopogon aciculatus*	CHAC
82	*Cissampelos mucronanta*	CIMU
83	*Chromalaena odoratum*	CHOD
84	*Chrysophyllum albidum*	CHAL
85	*Citrus sinensis*	CISI
86	*Clappertoniana ficifolia*	CLFI
87	*Cleistopholis paten*	CLPA
88	*Cleoma viscose*	CLVI
89	*Cnestis feruginea*	CNFE
90	*Cocos nucifera*	CONU

91	*Cochlospermum planchonii*	COPL
92	*Coffea brevipas*	COBR
93	*Cola afzelii*	COAF
94	*Cola gigantean*	COGI
95	*Cola milleni*	COMI
96	*Cola nitida*	CONI
97	*Combretum bracteaunm*	COBC
98	*Combretum hispidum*	COHI
99	*Combretum racemosum*	CORA
100	*Combretum molle*	COMO
101	*Combretum zenkeri*	COZE
102	*Commelina benghalensis*	COBE
103	*Commelina nodiflora*	CONO
104	*Conyza sumatrensis*	COSU
105	*Corchorus olitorius*	COOL
106	*Croton lobatus*	CRLO
107	*Crotolaria retusa*	CRRE
108	*Crassocephalum rubens*	CRRU
109	*Crescentia*	CRCU
110	*Cucurbita pepo*	CUPE
111	*Cucumeropsis manni*	CUMA
112	*Cussonia barteri*	CUBA
113	*Cyanolis lanata*	CYLA
114	*Cymbopogon giganteus*	CYGI
115	*Cyathula prostrata*	CYPR
116	*Cynodon dactylon*	CYDA
117	*Cynometra megalophylla*	CYME
118	*Cyperus articulatus*	CYAR
119	*Cyperus esculentus*	CYES
120	*Cyperus iria*	CYIR
121	*Dactyloctenium aegyptium*	DAAE
122	*Daniella olliverii*	DAOL
123	*Deloni regia*	DERE

124	*Deinbollia pinnata*	DEPI
125	*Desmodium salcifolium*	DESA
126	*Detarium macrocarpum*	DEMA
127	*Dialium guinensis*	DIGU
128	*Discorea prahensilis*	DIPR
129	*Dioseorea alata*	DIAL
130	*Discorea cayenensis*	DICA
131	*Diospyros mesipiliformis*	DIME
132	*Diospyros monbutensis*	DIMO
133	*Dichrostachys cinerea*	DICI
134	*Diplazium sammatii*	DISA
135	*Distemonanthus benthamanus*	DIBE
136	*Dracaena fragranus*	DRFR
137	*Eclipia alba*	ECAL
138	*Elaeisi guinensis*	ELGU
139	*Eleusine indica*	ELIN
140	*Entanda Africana*	ENAF
141	*Eragrostis tremula*	ERTR
142	*Erythrina senegalensis*	ERSE
143	*Erythrophleum suaveolensis*	ERSU
144	*Euphorbia hirta*	EUHI
145	*Euphorbia lateriflora*	EULA
146	*Ficus capensis*	FICA
147	*Ficus exasperata*	FIEX
148	*Ficus mucoso*	FIMU
149	*Ficus thioningii*	FITH
150	*Ficus sycomorus*	FISY
151	*Funtumia elastic*	FUEL
152	*Gardenia trenifolia*	GATE
153	*Gardenia aqaulla*	GAAQ
154	*Gliricidia sepium*	GLSE
155	*Glyphaea brevipes*	GLBR
156	*Gmelina arboreus*	GMAR

157	*Gossypium barbadense*	GOBA
158	*Grevia carpinifolia*	GRCA
159	*Grevia flavescens*	GRFL
160	*Greivia mollis*	GRMO
161	*Guarea cedrata*	GUCE
162	*Harrisonia abyssinica*	HAAB
163	*Hedranthera barteri*	HEBA
164	*Heinsia crinita*	HECR
165	*Hewittia sublobata*	HESU
166	*Hibiscus asper*	HIAS
167	*HIBIscus sabdarrifa*	HISA
168	*Hibiscus rostellatus*	HIRO
169	*Hiprocratea patten*	HIPA
170	*Hollarhena floribunda*	HOFL
171	*Holoptelia grandis*	HOGR
172	*Homalium letestui*	HOLE
173	*Hyparhenia involucrate*	HYIN
174	*Hyparhenia rufa*	HYRU
175	*Hmneocardia acida*	HYAC
176	*Icacinia tricantha*	ICTR
177	*Imperata cylindrical*	IMCY
178	*Indigofera capitata*	INCA
179	*Irvingia gabonensis*	IRGA
180	*Irvingia wombolu*	IRWO
181	*Ipomea asarifolia*	IPAS
182	*Jatropha carcass*	JACU
183	*Justicia flava*	JUFL
184	*Khaya ivorensis*	KHIV
185	*Kigelia africana*	KIAF
186	*Lannea nigritana*	LANI
187	*Lannea welwetehii*	LAWE
188	*Lannea taraxacifolia*	LATA
189	*Lagenaria siceranía*	LASI

190	*Laportea aestanus*	LAAE
191	*Leersia hexandra*	LAHE
192	*Lactuca capensis*	LACP
193	*Lantana camara*	LACA
194	*Lecaniodiscus cupanioides*	LECU
195	*Lonchocarpus cyanescens*	LOCY
196	*Lonchocarpus griffonianus*	LOGR
197	*Lophira lanceolata*	LOLA
198	*Lovoa trichiloides*	LOTR
199	*Ludiwigia deeuirens*	LUDE
200	*Macaranga barterii*	MABA
201	*Machrosphyra longistyla*	MALO
202	*Malotus oppositifolius*	MAOP
203	*Malancantha alnifolia*	MAAL
204	*Magnifera indica*	MAIN
205	*Malvastrum corimandelianum*	MACO
206	*Manihot esculenta*	MAES
207	*Maniophyton fulvum*	MAFU
208	*Maytenus senegalensis*	MASE
209	*Magariteria discoideae*	MADI
210	*Microdesmis puberula*	MIPU
211	*Milicia excels*	MIEX
212	*Mimosa pudica*	MIPD
213	*Manscus alternifolius*	MAAF
214	*Manscus flabelloformis*	MAFL
215	*Mitragyna inermis*	MIIN
216	*Melanthra scandens*	MESC
217	*Momordica charantai*	MOCH
218	*Mimosa invisa*	MIIV
219	*Morinda lucida*	MOLU
220	*Monodorna tennifolia*	MOTE
221	*Moringa oleifera*	MOOL
222	*Mucuna prurens*	MUPR

223	*Mucuna sloanei*	MUSL
224	*Musa sapientum*	MUSA
225	*Musa paradisiacal*	MUPA
226	*Myrianthus arboreus*	MYAR
227	*Nauchlea latifolia*	NALA
228	*Newbouldia laevis*	NELA
229	*Ocimum grattasimum*	OCGR
230	*Oryza longistanimata*	ORLO
231	*Ocimum canum*	OCCA
232	*Olax subarolata*	OLSB
233	*Olax subscorpoidea*	OLSU
234	*Opillia celtidifolia*	OPCE
235	*Panicum maximum*	PAMA
236	*Panicum laxum*	PALA
237	*Parinari robusta*	PARO
238	*Parinari polyandra*	PAPO
239	*Parkia becolor*	PABI
240	*Parkia biglobosa*	PABG
241	*Parinari glabra*	PAGL
242	*Parquettina nigreseen*	PANI
243	*Palisota hirsute*	PAHI
244	*Paspalum norranthus*	PANO
245	*Pennisetum pedicellatum*	PEPE
246	*Pennisetum purpureum*	PEPU
247	*Phyllanthus discoides*	PHDI
248	*Pilostigma thoningii*	PITH
249	*Poulilzozia giunensis*	POGU
250	*Paullinia pinnata*	PAPI
251	*Physalis micrantha*	PHMI
252	*Prosopis Africana*	PRAF
253	*Psorospermum febrifugum*	PSFE
254	*Paspalum conjugatum*	PACO
255	*Pterocarpus santalinoides*	PTSA

256	*Pupalia lappacea*	PULA
257	*Psidium guajava*	PSGU
258	*Peperomia pellucid*	PEPL
259	*Pterocarpus erinaceus*	PTER
260	*Pterocarpus mildbraedii*	PTMI
261	*Pennisetum violacea*	PEVI
262	*Raphia hookerii*	RAHO
263	*Reissantia indica*	RAIN
264	*Rhynchospora corymbosa*	RHCO
265	*Rauvolvisa vomitoria*	RAVO
266	*Ricinodendron heudelotii*	RIHE
267	*Ricinus communis*	RICO
268	*Rinoria dentrata*	RIDE
269	*Rothmania longiflora*	ROLO
270	*Sansevierasenegambica*	SASE
271	*Sanseviera liberica*	SALI
272	*Securidaca longipendiculata*	SELO
273	*Schramkia leptocarpa*	SCLE
274	*Securinega virosa*	SEVI
275	*Scleria verrucosa*	SCVE
276	*Sesamium indicum*	SEIN
277	*Senna hirsute*	SEHI
278	*Sida acuta*	SIAC
279	*Sida corymbosa*	SICO
280	*Smilax krausiana*	SMKR
281	*Solanum aethiopicum*	SOAE
282	*Seteria megaphylla*	SEME
283	*Solanum americanum*	SOAM
284	*Solanum dasyphyllum*	SODA
285	*Solenostemon monostachyus*	SOMO
286	*Solanum erianthum*	SOER
287	*Solanum macrocarpum*	SOMA
288	*Spathoidea campanulata*	SPCA

289	*Spondias mombim*	SPMO
290	*Sphenocentrum jollyanum*	SPJO
291	*Sterculia tragacantha*	STTR
292	*Struchium sparganophora*	STSP
293	*Syndrella nodiflora*	SYNO
294	*Tamarindus indica*	TAIN
295	*Talinum triangulare*	TATR
296	*Tectona grandis*	TEGR
297	*Tephrosia braceolata*	TEBR
298	*Tephrosia pedicellata*	TEPE
299	*Terminalia glaucesceus*	TEGL
300	*Terminalia superb*	TESU
301	*Theobroma cacao*	TACA
302	*Tithonia divesifolia*	TIDI
303	*Trema orientalis*	TRDR
304	*Tridax procumbens*	TRPR
305	*Triplochiton sclerotylon*	TRSC
306	*Trumtet cordifolia*	TRCO
307	*Uvaria chamae*	UVCH
308	*Urenia lobata*	URLO
309	*Vernonia amygdalina*	VEAM
310	*Vernonia ambigua*	VEAB
311	*Vernonia anercii*	VEAN
312	*Vernonia perrottetii*	VEPE
313	*Vitex doniana*	VIDO
314	*Waltheria indica*	WAIN
315	*Xylopia quintasii*	XYDU
316	*Zanthoxylum zanthoxyloides*	ZAZA
317	*Vitellaria paradoxa*	VIPA

Table 2: Average Frequency of Plants in the Study Area

Plant Specie	Frequency	Percent	Valid Percent	Cumulative Percent
Acalypha ciliate	8	.7	.7	.8
Afzelia Africana	10	.9	.9	1.8
Albizia lebeck	2	.2	.2	1.9
Albizia zygia	1	.1	.1	2.0
Alchornea cordifolia	10	.9	.9	3.0
Alstonia boonei	14	1.3	1.3	4.3
Amaranthus hybridus	20	1.9	1.9	6.1
Anacardium occidentalis	2	.2	.2	6.3
Anchomaiamis difformis	15	1.4	1.4	7.7
Andropogon gayanus	22	2.0	2.0	9.7
Andropogon tectorum	22	2.0	2.0	11.8
Annona senegalensis	5	.5	.5	12.2
Anogeisus leiocarpus	5	.5	.5	12.7
Anthoclesta vogelii	3	.3	.3	13.0
Antiaris Africana	6	.6	.6	13.5
Aspilia Africana	18	1.7	1.7	15.2
Astonia boonei	4	.4	.4	15.6
Azadirachta indica	1	.1	.1	15.6
	3	.3	.3	15.9

Barhania monodora	8	.7	.7	16.7
Bidiens pilosa	8	.7	.7	17.4
Blighia welwetchii	14	1.3	1.3	18.7
Boerhavia coccinea	8	.7	.7	19.4
Boerhavia diffussa	4	.4	.4	19.8
Borreria veticulata	1	.1	.1	19.9
Bridelia ferruginea	30	2.8	2.8	22.7
Bridelia feruginea	16	1.5	1.5	24.2
Bridelia micrantha	6	.6	.6	24.7
Bridellia micrantha	2	.2	.2	24.9
Canthium volgeri	6	.6	.6	25.5
Carica papaya	11	1.0	1.0	26.5
Carpolobia lurea	2	.2	.2	26.7
Casia mimosoides	6	.6	.6	27.2
Casia podocarpa	9	.8	.8	28.1
Cassia mimosoides	9	.8	.8	28.9
Cassia podocarpa	1	.1	.1	29.0
Ceiba pentandra	15	1.4	1.4	30.4
Centrosema puebescen	25	2.3	2.3	32.7
Chromolaena odoratum	6	.6	.6	33.2
Cissampelos micronantha	1	.1	.1	33.3
Cissus arguata	11	1.0	1.0	34.4
Cleome viscose	1	.1	.1	34.4
Cnestis ferruginea	2	.2	.2	34.6
Cochlospermum planchonii	16	1.5	1.5	36.1
Coehlospermum planchoni	8	.7	.7	36.9
Cola millenii	12	1.1	1.1	38.0
Combretum hispidum				

Combretum molle	18	1.7	1.7	39.6
Combretum nigerica	2	.2	.2	39.8
Combretum racemosum	6	.6	.6	40.4
Combretum zenkerii	8	.7	.7	41.1
Commelina benghalensis	8	.7	.7	41.9
Commelina nodiflora	15	1.4	1.4	43.2
Corchorus olitoriuos	9	.8	.8	44.1
Cussonia barterii	9	.8	.8	44.9
Cymbopogon giganteus	6	.6	.6	45.5
Cynodon dactylon	4	.4	.4	45.8
Cynometra megallophylla	8	.7	.7	46.6
Cyperrus articularius	7	.6	.6	47.2
Daniella olliveri	21	1.9	1.9	49.2
Delonix regia	4	.4	.4	49.5
Desmodium salutolium	6	.6	.6	50.1
Detarium macrcapum	2	.2	.2	50.3
Diplazium samatii	7	.6	.6	50.9
Elaeis guineensis	2	.2	.2	51.1
Eleusine indica	13	1.2	1.2	52.3
Entada abicinica	1	.1	.1	52.4
Entanda Africana	4	.4	.4	52.8
Eragrostis tremula	4	.4	.4	53.1
Euphorbia hirta	4	.4	.4	53.5
Euphorbia laterflora	5	.5	.5	54.0
Ficus capensis	17	1.6	1.6	55.6
Ficus exasperate	21	1.9	1.9	57.5
Ficus sur	1	.1	.1	57.6
Ficus sycommorus	9	.8	.8	58.4

Funfumia elastic	6	.6	.6	59.0
Gardenia aqualla	4	.4	.4	59.4
Gardenia rubiscens	3	.3	.3	59.6
Holarrhena floribunda	3	.3	.3	59.9
Hymenocardia acida	12	1.1	1.1	61.0
Hypocrata pallens	1	.1	.1	61.1
Hyptis suaveolens	1	.1	.1	61.2
Imperata cylindrical	17	1.6	1.6	62.8
Indigofera capitata	4	.4	.4	63.1
irvingia wombolu	10	.9	.9	64.1
Jatropha curcas	7	.6	.6	64.7
Lantana camara	6	.6	.6	65.3
Lantema camoma	7	.6	.6	65.9
Lonchocarpus cyacems	3	.3	.3	66.2
Lonchocarpus sericens	1	.1	.1	66.3
Macarange barrteri	7	.6	.6	66.9
Magaritaria discoides	4	.4	.4	67.3
Malacantha alnifolia	2	.2	.2	67.5
Mangifera indica	1	.1	.1	67.6
Mucuna prurens	1	.1	.1	67.7
Myrianthus arboreus	14	1.3	1.3	69.0
Nuclea latifolia	1	.1	.1	69.1
Occimum canon	4	.4	.4	69.4
Occimum gratissimum	8	.7	.7	70.2
Olax secopoides	7	.6	.6	70.8
Panieum maximum	13	1.2	1.2	72.0
Parinari glabra	6	.6	.6	72.6
Parinari polyandra	4	.4	.4	73.0

Parinari robusta	4	.4	.4	73.3
Parkia bicolor	17	1.6	1.6	74.9
Parkia biglobasa	7	.6	.6	75.6
Parkia biglobosa	8	.7	.7	76.3
Parkia biglobossa	6	.6	.6	76.9
Paspalum conjugatum	9	.8	.8	77.7
Paspalum nonathum	2	.2	.2	77.9
Pauridiantah hirttela	6	.6	.6	78.4
Pauridiantha hirttela	3	.3	.3	78.7
Pavetta corymbosa	1	.1	.1	78.8
Pennisetum pedicellatum	19	1.8	1.8	80.6
Prosopis Africana	8	.7	.7	81.3
Psarospermum febrifuga	8	.7	.7	82.0
Securidaea longipendicula	12	1.1	1.1	83.1
Sema hirsute	2	.2	.2	83.3
Senna hirsute	7	.6	.6	84.0
Sinolax crucicina	1	.1	.1	84.1
Smilax kruciana	3	.3	.3	84.4
Solanum eriantum	12	1.1	1.1	85.5
Solanum macrocarpum	6	.6	.6	86.0
Solenostrenum monostachyc	8	.7	.7	86.8
Spandias mombim	14	1.3	1.3	88.1
Sphenocentron jollyanum	6	.6	.6	88.6
Spondias mombim	2	.2	.2	88.8
Sterculia tragacantha	10	.9	.9	89.7
Stragia spp	5	.5	.5	90.2
Syndrella nodiflora	10	.9	.9	91.1
	10	.9	.9	92.0

Tectona grandis				
Tephrosia braceolata	10	.9	.9	93.0
Tephrosia pedicellata	10	.9	.9	93.9
Terminalia glaucescens	18	1.7	1.7	95.6
Vernonia amygdalina	10	.9	.9	96.5
Vipellaria paradoxa	8	.7	.7	97.2
Vitellaria paradoxa	4	.4	.4	97.6
Vitex doniana	9	.8	.8	98.4
Vittelaria paradoxum	1	.1	.1	98.5
Waltheria indica	16	1.5	1.5	100.0
Total	1080	100.0	100.0	

Source: Field Survey (2005 – 2008)

Analysis of Variance of Plants Abundance for Raining Season

	Sum of Squares	Df	Mean Squares	F	Sig.
Between Groups	231393.500	12	1932.792	5330.741	0.000
Within Groups	386.867	1067	0.363		
Total	23580.367	1079			

Source: Field Survey (2005 – 2008)

Analysis of Plants Abundance for Dry Season

	Sum of Squares	Df	Mean Squares	F	Sig.
Between Groups	16057.7550	12	1338.129	1535.663	0.000
Within groups					
Total					

Source: Field Survey (2005 – 2008)

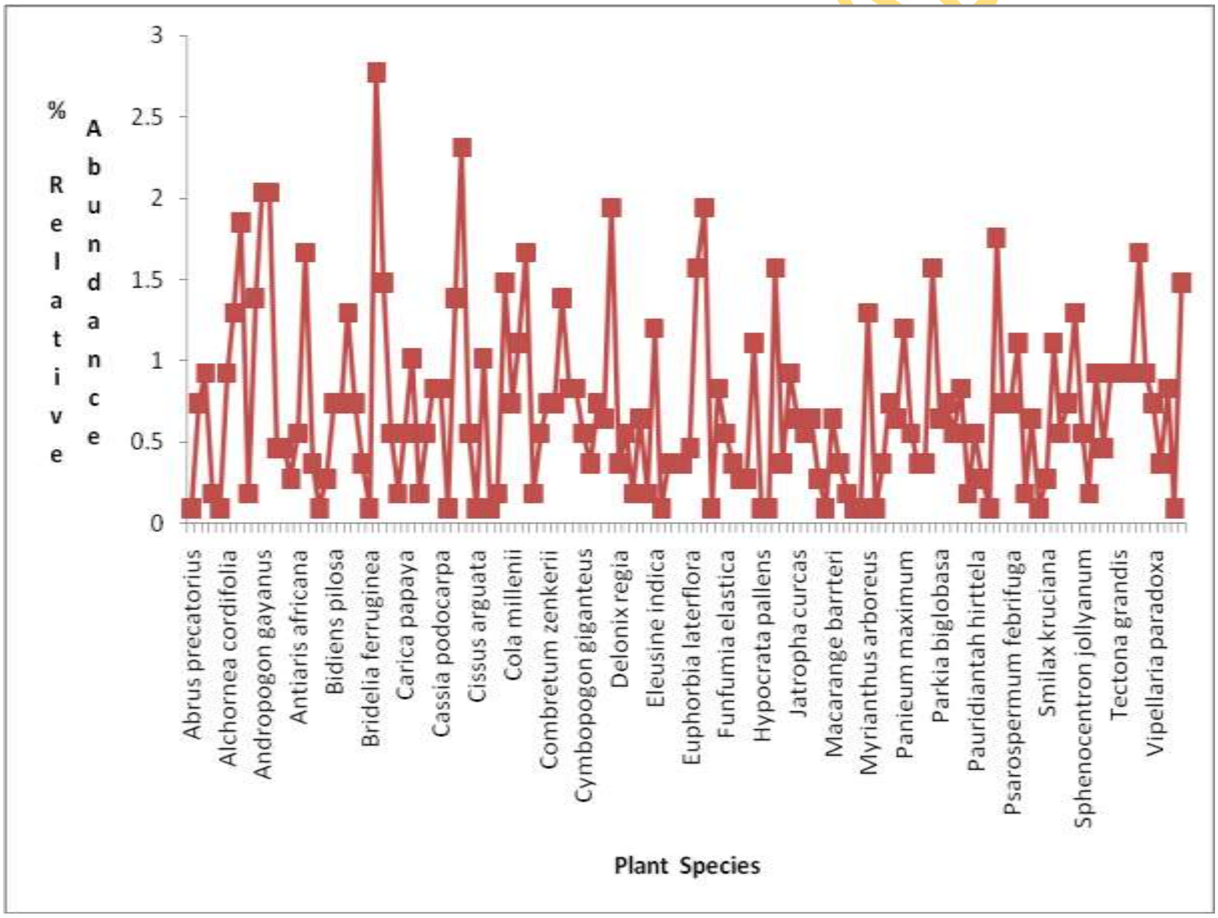

Fig. 3: Percentage Average Relative Abundance of Plant Species in the Study Area
Source: Field Survey (2005 – 2008)

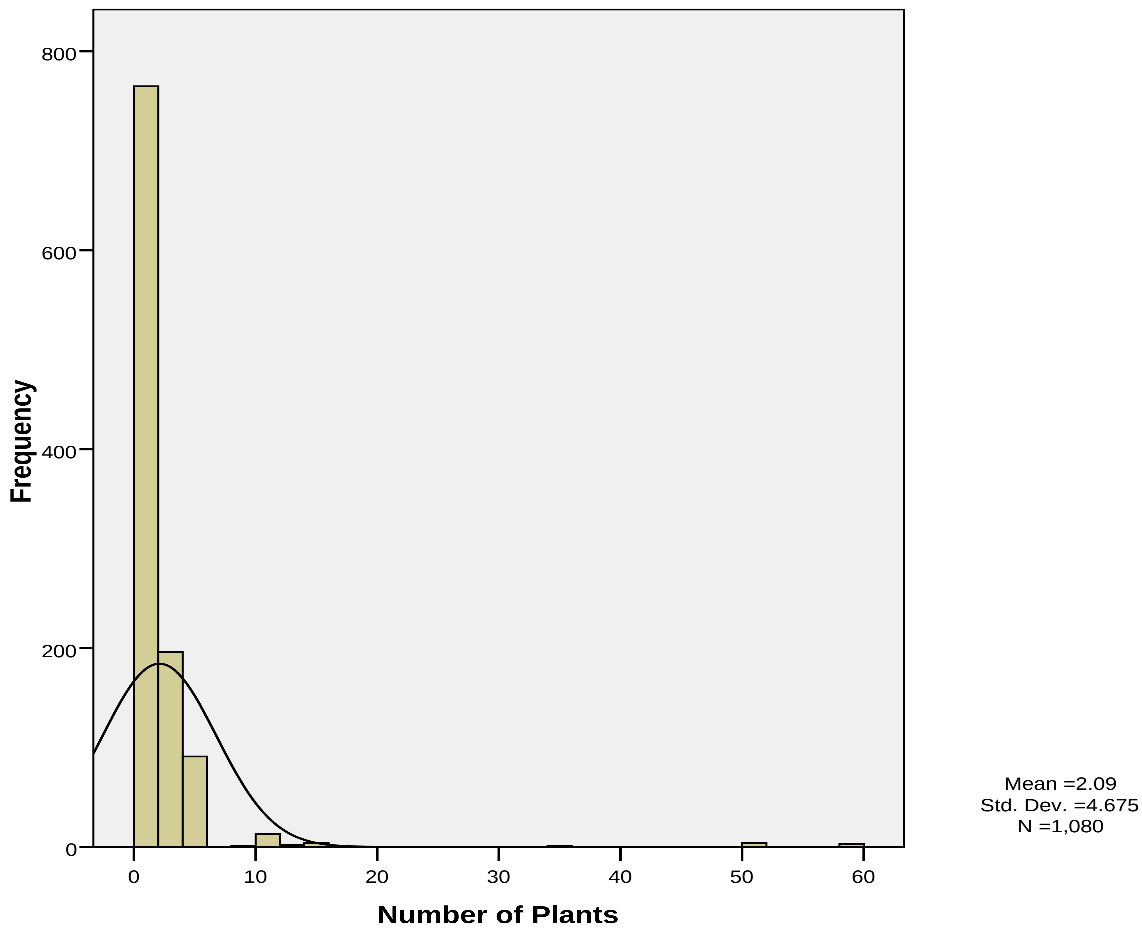

Fig. 4: Average Raining Season Plant Species Frequency of Abundance
Source: Field Survey (2005 – 2008)

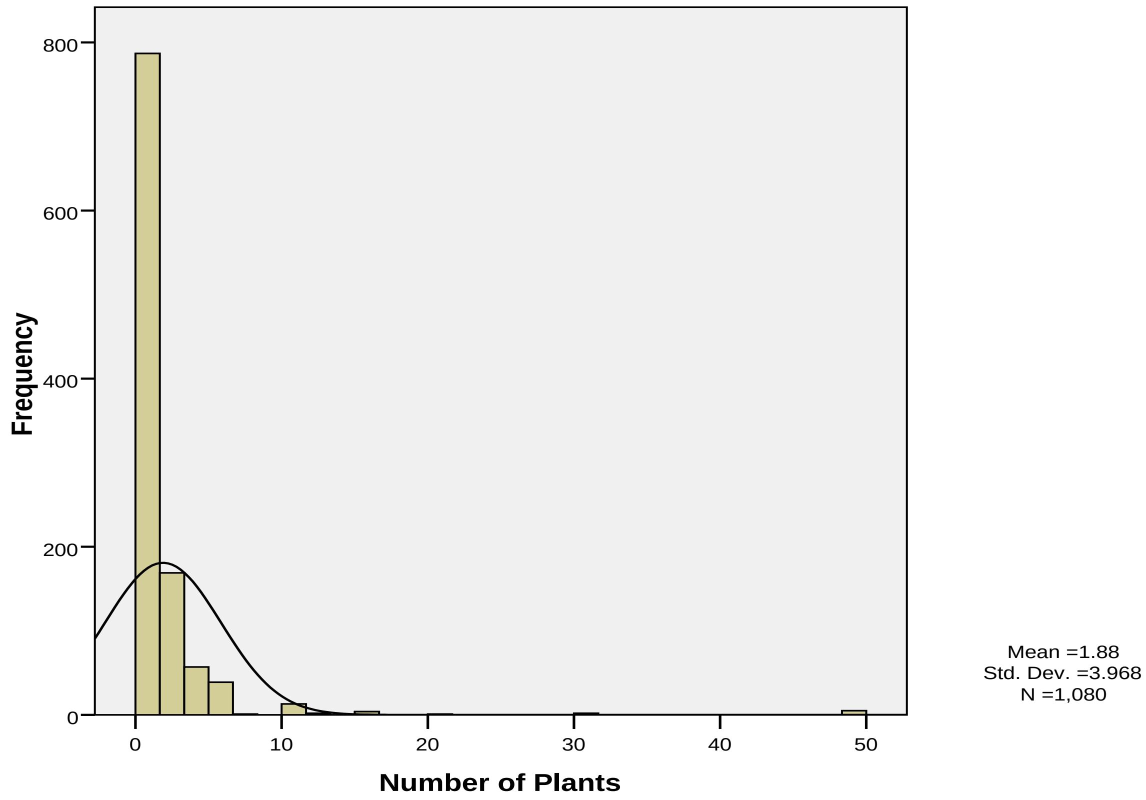

Fig. 5 : Average Dry Season Plant Species Frequency of Abundance
Source: Field Survey (2005 – 2008)

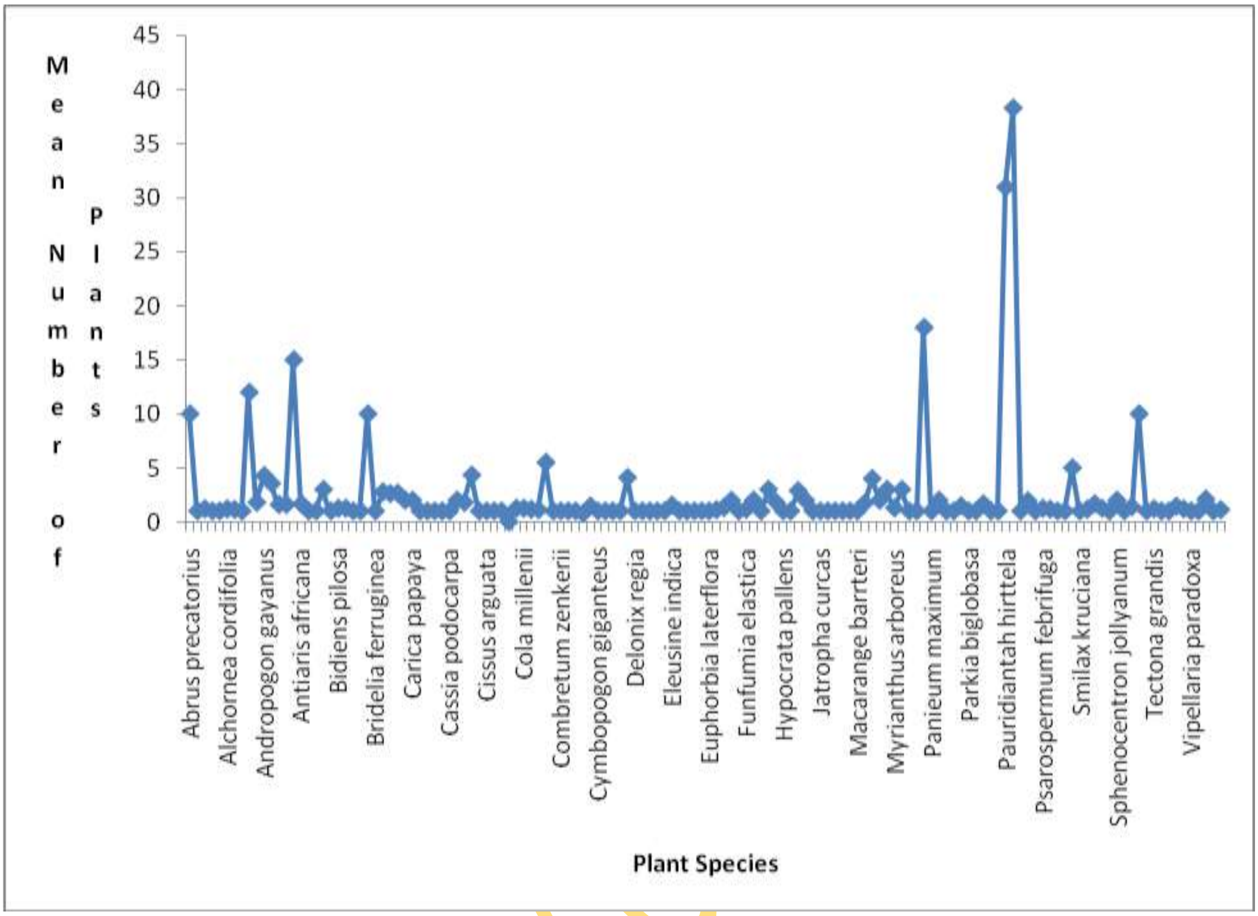

Fig. 6: Rainy Season Mean Number of Plants per plot in the Study Area
Source: Field Survey (2005 – 2008)

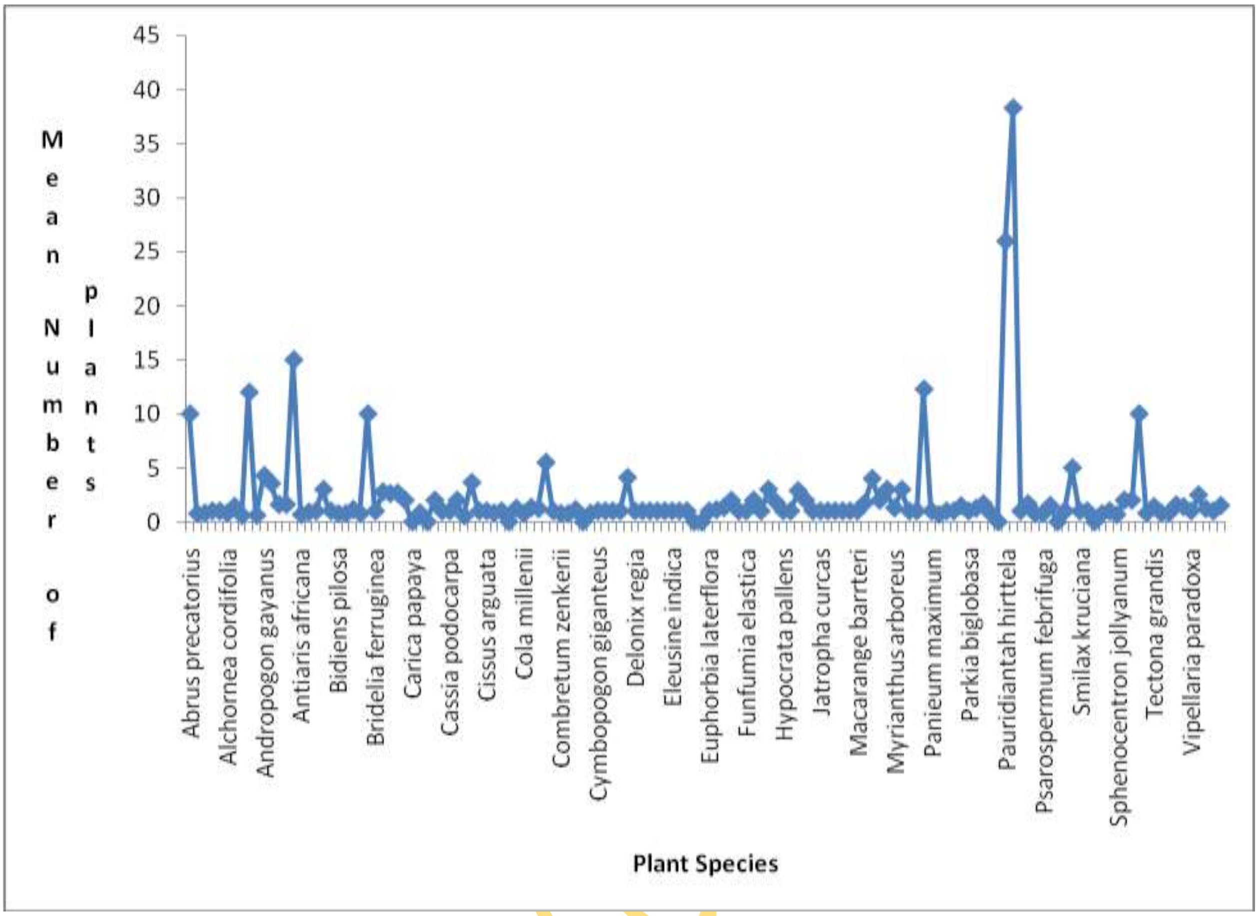

Fig. 7: Dry Season Mean Number of Plants per plot in the Study Area
Source: Field Survey (2005 – 2008)

4.2 ANIMAL FREQUENCY DISTRIBUTION AND RELATIVE ABUNDANCE

In all 0ne thousand eight hundred and twenty – four (1824) animals were observed either by direct sighting and indices during the study. The animals belong to forty (40) species from thirty – one (31) family. The average frequency of animals in the study area is shown in table 4. The monthly abundance of animals is shown in table 7. The cane rat (*Thryonomys swinderianus*) was the most abundant species followed by Ground squirrel (*Xerus erythrocepus*), Maxwell duiker (*Cephalopus maxwelli*) and Giant rat (*Cricetomys gambianus*).

Table 3: Scientific names and Codes of Animals in the Study Site

COUPLET NO.	SCIENTIFIC NAME	ENGLISH NAME	CODE
1	*Actophilornis africana*	Lily rotter	ACAF
2	*Agama agama*	Agama lizard	AGAG
3	*Ardea cinera*	Grey heron	ARCI
4	*Arvicanthus niloticus*	Nile rat	ARNI
5	*Artheris chloraechis*	Brown snake	ARCH
6	*Anthus leucophrys*	Plainbacked pipit	ANLE
7	*Bitis gabonica*	Gabon viper	BIGA
8	*Bostrichia hagedash*	Hadada ibis	BOHA
9	*Bothropthalmus ,ineatum*	Sidestripe brown snake	BOLI
10	*Bulbulcus ibis*	Cattle egret	BUIB
11	*Burhinus senegalensis*	Senegal thick snale	BUSE
12	*Carprimulgus spp*	Night jar	CASP
13	*Centropus grilli*	Black coucal	CEGR
14	*Centropus senegalensis*	Senegal coucal	CESE
15	*Cephalophus maxwellii*	Maxwell duiker	CEMA
16	*Cephalophus rufilatus*	Red flanked duiker	CERU
17	*Cephalophus spp*	Duiker	CESP
18	*Cercopitheecus mona*	Mona monkey	CEMO
19	*Ceryle rudis*	Pied king fisher	CERU
20	*Ciconia abdmii*	Abdim stork	CIAB
21	*Cisticola cantan*	Lanceolated warbier	CICA
22	*Cisticola galactotes*	Grass wabler	CIGA
23	*C,amator glandarius*	Great spottted cukoo	CLGA
24	*Clamator jacobinus*	Jaccobin cukoo	CLJA
25	*Clamator levallanti*	Levaillantafrican cukoo	CLLE
26	*Coracias abysinica*	Abysinia roller	COAB
27	*Coracias cyanogaster*	Bleud bellied roller	COCY
28	*Corvinella corvine*	Long tail shrike	COCO
29	*Corvus albus*	Pied cow	COAL
30	*Corythaeola cristata*	Blue plantain eater	COCR
31	*Cricetomys gamianus*	Giant rat	CRGA
32	*Crinifer piscator*	Grey plantain eater	CRPI
33	*Cypsiuurus parvus*	African palm swift	CYPA

34	*Dendroaspis virindis*	Green mamba	DEVI
35	*Dendrocygna viduata*	White faced tree duck	DEVD
36	*Dendrohyrax dorsalis*	Tree hyrax	DEDO
37	*Dendropicos fuscescens*	Cardinal woodpecker	DEFU
38	*Epixerus ebii*	Red headed tree squirrel	EPEB
39	*Erythrocebus patas*	Patas monkey	ERPA
40	*Estrilda melpoda*	Orange cheeked waxbill	ESME
41	*Euplectes orix*	Red bishop	EUOR
42	*Euplectes macrourus*	Yellow mantle whydah	EUMA
43	*Francolinus bicalcaratus*	Francolin (Bush fow)	FRBI
44	*Fraseria ocreata*	Fraser forest flycatcher	FROC
45	*Genetta macullatta*	Forest genet (Maloko)	GEMA
46	*Genetta trigrina*	Serval cat (Ogbo)	GETR
47	*Gypohierax angolensis*	Plamnut vulture	GYAN
48	*Halcyon leucocephala*	Grey headed kingfisher	HALE
49	*Halcyon malimbica*	Blue breasted kingfisher	HAMA
50	*Hacyon senegalensis*	Sengal kingfisher	HASE
51	*Haliatus vocifer*	Fish (River) Eagle	HAVO
52	*Heliosciurus puncatus*	Small forest swallow	HEPU
53	*Hirundo semirufa*	Rufuos chested swallow	HISE
54	*Hirundo senegalensis*	Mospue swallow	HISG
55	*Hylochoerus minertzhageni*	Bush pig	HYMI
56	*Hystrix cristata*	Crested porcupine	HYCR
57	*Indicator indicator*	Greater honey guide	ININ
58	*Indicator minor*	Lesser honey guide	INMI
59	*Kaupifalco monogrammiscus*	Lizard Buzzard	KAMO
60	*Logonosticta senegala*	Senegal fire finch	LASE
61	*Lamptotornis spp*	Glossy starlings	LASP
62	*Laniarus artoflavus*	Yellow billed shrike	LAAR
63	*Lemniscormys striatus*	Spotted grass mouse	LEST
64	*Lepus capensis*	Hare	LECA
65	*Lonhura bicolor*	Black and white manikin	LOBI
66	*Lonchura cucullata*	Bronse manikin	LOCU
67	*Lophuromys sikapusi*	Rufuos bellied rat	LOSI
68	*Lybius veilliot*	veilliot barbet	LYNE
69	*Macronyx crocent*	Yellow throated long claw	MACR
70	*Merops albicolis*	White throated bee eater	MEAL
71	*Merops malimbicus*	Rosy bee eater	MEMA
72	*Merops muellenii*	Black headed bee eater	MEMU

73	*Merops nubicus*	Carmine bee eater	MENU
74	*Micropus caffer*	White rumped swift	MICA
75	*Milvus migrans*	Black kite	MIMI
76	*Motacilla flava*	Yellow wagtail	MOFL
77	*Mungos obsciurus*	Long nose mongoose	MUOB
78	*Mus minutoides*	Pigmy mouse	MUMI
79	*Musophaga violacea*	Violet plantain eater	MUVI
80	*Naja melanoleuca*	Black cobra	NAME
81	*Numida meleagris*	Giunea fowl	NUME
82	*phoeniculus atterimus*	Lesser (Green) wood hoope	PHAT
83	*Phylloscopus trochillus*	Wilow warbler	PHTR
84	*Ploceus cucullatus*	Village weaver bird	PLCU
85	*Ploceus melanocephalus*	Black headed weaver	PLME
86	*Pogonileus subsulpheus*	Yellow rumped tinker bird	POSU
87	*Poicephalus senegalus*	Senegal parrot	POSE
88	*Polyboroides radiates*	Harrier hawk	PORA
89	*Procavia ruficeps*	Rock hyrax	PRRU
90	*Protexerus aubinni*	Slender tailed squirrel	PRAU
91	*Protexerus strangerii*	Gaint forest squirel	PRST
92	*Psamophis sibilans*	Yellow stripe snake	PSSI
93	*Psamophis sibilans philipsii*	Yellow snake	PSSP
94	*Pyconotus barbatus*	Common garden bulbul	PYBA
95	*Python sebae*	Rock python	PYSE
96	*Rattus natalensis*	Muiltimammate rat	RANA
97	*Rousethus smithii*	Fruit bat	ROSM
98	*Schoenicola platyura*	Fan tailed swamp barbler	SCPL
99	*Scopus umbretta*	Hammerkop	SCUM
100	*Sphenoeacus mentalis*	Moustached grass warbler	SPME
101	*Streptopelia decipens*	African (morning) dove	STDE
102	*Streptopelia senegalensis*	Laughing dove	STSE
103	*Streptopelia semitorquata*	Red Eyed dove	STSQ
104	*Streptopelia turtur*	European turtle dove	STTU
105	*Streptopelia vinacea*	Veinaceous dove	STVI
106	*ateri kempi*	Kemps gerbil	TAKE
107	*Thryonomys swinderianus*	Grasscutter	THSW
108	*Tockus erthorhyncus*	African hornbill	TOER
109	*Tockus nasutus*	Afrcan grey hornbill	TONA
110	*Tragelaphus scriptus*	Bush buck	TRSC
111	*Teron australis*	Green pigeon fruit	TRAU

112	*Turdoides reinwardii*	Black cap barbler	TURE
113	*Turdus Pelios*	West African thrush	TUPE
114	*Tyto alba*	Owl	TYAL
115	*Veranus examthematicus*	Short tailed Nile monitor	VEEX
116	*Veranus niloticus*	Monitor lizard	VENI
117	*Viverra civetta*	Civet cat	VICI
118	*Vidua macroura*	Pin tailed whydah	VIMA
119	*Xerus erythropus*	White stripe ground squirel	XEER
120	*Xerus sp*	Plain body ground squirel	XESP
121	*Zosterops senegalensis*	Yellow white eye	ZOSE

Table 4 : Average Frequency of Animals in the Study Area

Name of Animal	Frequency	Percent	Valid Percent	Cumulative Percent
Anthus leueophrys	24	1.3	1.3	1.3
Arvicauthus niloticus	122	6.7	6.7	8.0
Bothrophthalmus lineatus	4	.2	.2	8.2
Bulbulcus ibis	58	3.2	3.2	11.4
Centropus senegalensis	56	3.1	3.1	14.5
Cephalophus maxwellii	22	1.2	1.2	15.7
Cephalophus spp	89	4.9	4.9	20.6
Cercopithecus mona	12	.7	.7	21.2
Corvus albus	48	2.6	2.6	23.8
Cricetomys gambianus	73	4.0	4.0	27.9
Cypsiurus parvus	24	1.3	1.3	29.2
Epixerus ebii	12	.7	.7	29.8
Francolinus bicalcaratus	107	5.9	5.9	35.7
Hylochocrus minertzhage	12	.7	.7	36.3
Kaupifalco monogrammicus	44	2.4	2.4	38.8
Lemniscomys striatus	36	2.0	2.0	40.7
Lephuromys sikapusi	24	1.3	1.3	42.1
Lepus capensis	116	6.4	6.4	48.4
Lonchura cucullata	24	1.3	1.3	49.7
Merops malimbicus	24	1.3	1.3	51.0
Milvus migrans	24	1.3	1.3	52.4
Mungos obscures	12	.7	.7	53.0
Numida meleagris	60	3.3	3.3	56.3
Otus senegalensis	12	.7	.7	57.0
Ploceus capensis	5	.1	.1	57.0
Ploceus cucullatus	35	1.9	1.9	58.9
Protexerus aubinnii	12	.7	.7	59.6
Protexerus strangerii	11	.6	.6	60.2
Psammophis sibilous Philip	12	.7	.7	60.9
Sphenoeacus mentalis	12	.7	.7	61.5
Streptopelia turtur	24	1.3	1.3	62.8
Tateri kempi	12	.7	.7	63.5
Thryonomys swinderianus	319	17.5	17.5	81.0
Tockus nasutus	12	.7	.7	81.6
Tragelaphus scriptus	72	3.9	3.9	85.6
Treron australis	23	1.3	1.3	86.8
Varanus niloticus	12	.7	.7	87.5
Viverra civeta	61	3.3	3.3	90.8
Willow warbler **	24	1.3	1.3	92.2
Xerus erythropus	143	7.8	7.8	100.0
Total	1824	100.0	100.0	

Source: Field Survey (2005 – 2008)

Analysis of Variance of Distance of Sighting Animals and Season

Model	Sum of Squares	Df	Mean Squares	F	Sig.
Regression	29933290	2		54.140	0
Residual	5.03E+08	1821	14966645.097		.000[a]
Total	5.33E+08	1823			
			276445.152		

a. Predictors: (Constant), dry , wet
b. Dependent Variable: Distance

Source: Field Survey (2005 – 2008)

Analysis of Variance of Animal Order and Season

Model	Sum of Squares	Df	Mean Squares	F	Sig.
Regression	52.514	2	26.257	28.758	0 .0000[a]
Residual	1662.643	1821	.913		
Total	1715.158	1823			

Source: Field Survey (2005 – 2008)

Table 5: Mode of Animal Identification

Mode of Animal Identification	Frequency	Percent	Valid Percent	Cumulative Percent
Direct	793	43.1	43.1	44.0
Dung pol	36	2.0	2.0	46.0
Egg shel	12	0.7	0.7	46.6
Fd & pt	333	18.1	18.1	64.7
feacal p	34	1.8	1.8	66.6
Feather	24	1.3	1.3	67.9
Ft prt	208	11.3	11.3	79.2
Hole	128	6.9	6.9	86.1
HYMI	6	0.3	0.3	86.4
Nest	49	2.7	2.7	89.1
Nest cou	22	1.2	1.2	90.3
Pellet	118	6.4	6.4	96.7
Reptile	1	0.1	0.1	96.7
Sand bat	12	0.7	0.7	97.4
Stand bi	12	0.7	0.7	98.0
Trail	36	2.0	2.0	100.0
Total	1842	100.0	100.0	

Source: Field Survey (2005 – 2008)

Table 6: Crosstabs of Animal Abundance and Distance

Animal	Distance				
Code Name	250.00	750.00	1250.00	1750.00	Total
ANLE	0	0	12	12	24
ARNI	90	20	12	0	122
BOLI	0	4	0	0	4
BUIB	13	20	13	12	58
CEMA	0	0	4	18	22
CEMO	1	0	2	9	12
CESE	3	19	19	15	56
CESP	1	27	46	15	89
COAL	1	1	34	12	48
CRGA	3	32	10	28	73
CYPA	0	0	10	14	24
EPEB	1	10	1	0	12
FRBI	16	50	40	1	107
HYMI	1	0	4	7	12
KAMO	0	9	11	24	44
LECA	29	29	44	14	116
LESI	14	10	0	0	24
LEST	25	0	11	0	36
LOCU	24	0	0	0	24
MEMA	1	22	1	0	24
MIMI	0	0	7	17	24
MUOB	1	0	8	3	12
NUME	0	1	15	44	60
OTSE	1	2	9	0	12
PLCA	1	0	0	0	1
PLCU	35	0	0	0	35
PRAU	1	0	8	3	12
PRST	1	0	4	6	11
PSSI	1	0	0	11	12
SPME	1	0	0	11	12
STTU	0	0	1	23	24
TAKE	12	0	0	0	12
THSW	50	130	61	78	319
TONA	1	0	2	9	12
TRAU	0	17	6	0	23
TRSC	1	23	1	47	72
VANI	12	0	0	0	12
VICI	1	11	49	0	61
WIWA	1	23	0	0	24
XEER	43	43	35	22	143
Total	386	503	480	455	1824

Source: Field Survey (2005 – 2008)

Table 7: Monthly Abundance of Animals

	Month												Total
CodeName	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
ANLE	2	2	2	2	2	2	2	2	2	2	2	2	24
ARNI	10	10	10	10	11	11	10	10	10	10	10	10	122
BOLI	1	1	1	1	0	0	0	0	0	0	0	0	4
BUIB	4	4	5	4	4	4	6	6	6	6	5	4	58
CEMA	2	1	2	2	1	2	2	2	2	2	2	2	22
CEMO	1	1	1	1	1	1	1	1	1	1	1	1	12
CESE	4	4	4	4	5	5	5	5	5	5	5	5	56
CESP	7	9	8	8	8	7	7	7	7	7	7	7	89
COAL	4	4	4	4	4	4	4	4	4	4	4	4	44
CRGA	6	6	6	7	6	6	6	6	6	6	6	6	73
CYPA	2	2	2	2	2	2	2	2	2	2	2	2	24
EPEB	1	1	1	1	1	1	1	1	1	1	1	1	12
FRBI	8	9	9	9	9	9	9	9	9	9	9	9	107
HYMI	1	1	1	1	1	1	1	1	1	1	1	1	12
KAMO	3	3	3	3	4	4	4	4	4	4	4	4	44
LECA	9	10	9	10	9	9	10	10	10	10	10	10	116
LESI	2	2	2	2	2	2	2	2	2	2	2	2	24
LEST	3	3	3	3	3	3	3	3	3	3	3	3	36
LOCU	2	2	2	2	2	2	2	2	2	2	2	2	24
MEMA	2	2	2	2	2	2	2	2	2	2	2	2	24
MIMI	2	2	2	2	2	2	2	2	2	2	2	2	24
MUOB	1	1	1	1	1	1	1	1	1	1	1	1	12
NUME	5	5	5	5	5	5	5	5	5	5	5	5	60
OTSE	1	1	1	1	1	1	1	1	1	1	1	1	12
PLCA	1	0	0	0	0	0	0	0	0	0	0	0	1
PLCU	2	3	3	3	3	3	3	3	3	3	3	3	35
PRAU	1	1	1	1	1	1	1	1	1	1	1	1	12
PRST	1	0	1	1	1	1	1	1	1	1	1	1	11
PSSI	1	1	1	1	1	1	1	1	1	1	1	1	12
SPME	1	1	1	1	1	1	1	1	1	1	1	1	12
STTU	2	2	2	2	2	2	2	2	2	2	2	2	24
TAKE	1	1	1	1	1	1	1	1	1	1	1	1	12
THSW	25	26	26	27	27	27	26	27	27	27	27	27	319
TONA	1	1	1	1	1	1	1	1	1	1	1	1	12
TRAU	1	2	2	2	2	2	2	2	2	2	2	2	23
TRSC	6	6	6	6	6	6	6	6	6	6	6	6	72
VANI	1	1	1	1	1	1	1	1	1	1	1	1	12
VICI	6	5	5	5	5	5	5	5	5	5	5	5	61
WIWA	2	2	2	2	2	2	2	2	2	2	2	2	24
XEER	11	12	12	12	12	12	12	12	12	12	12	12	143
Total	146	150	151	153	152	152	153	154	154	154	153	152	1824

Source: Field Survey (2005 – 2008)

Table 8: Crosstab of Distance and Order

	Order			Total
Distance	Mammal	Reptile	Bird	
250.00	248	13	125	386
750.00	324	4	175	503
1250.00	276	0	204	480
1750.00	242	11	202	455
Total	1090	28	706	1824

Source: Field Survey (2005 – 2008)

Table 9: Regression Analysis of Distance of Sighting and Season

	Distance	Wet	Dry
Pearson Correlation Distance	1.000	-.169	-.144
Wet	-.169	1.000	-.122
Dry	-.144	-.122	1.000
Sig. (1-tailed) Distance	.	.000	0.000
Wet	.000	.	0.000
Dry	.000	.000	.
N Distance	1824	1824	1824
Wet	1824	1824	1824
Dry	1824	1824	1824

Source: Field Survey (2005 – 2008)

Table 10: Land Use Changes in the Study Area (1984 - 2008)

Land use Categories	Area Extent (ha) 1984	2008	Percentage of Total (%) 1984	2008	Amount of Change from 1884 – 2008	Percentage of Change of the land %
Agricultural tree crop	0.00	106.15	0.00	1.03	106.15	100.00
Built up areas	0.00	108.85	0.00	1.06	108.85	100.00
Disturbed Forest	2051.32	1537.72	20.00	14.99	-513.6	-33.4
Extensive farmland	1538.49	1394.90	15.00	13.60	-143.59	-10.30
Intensive farmland	1846.19	1517.98	18.00	14.80	-328.21	-21.6
Road	82.05	206.67	0.80	2.02	124.62	60.3

Source: Planning Unit UNAAB (2009)

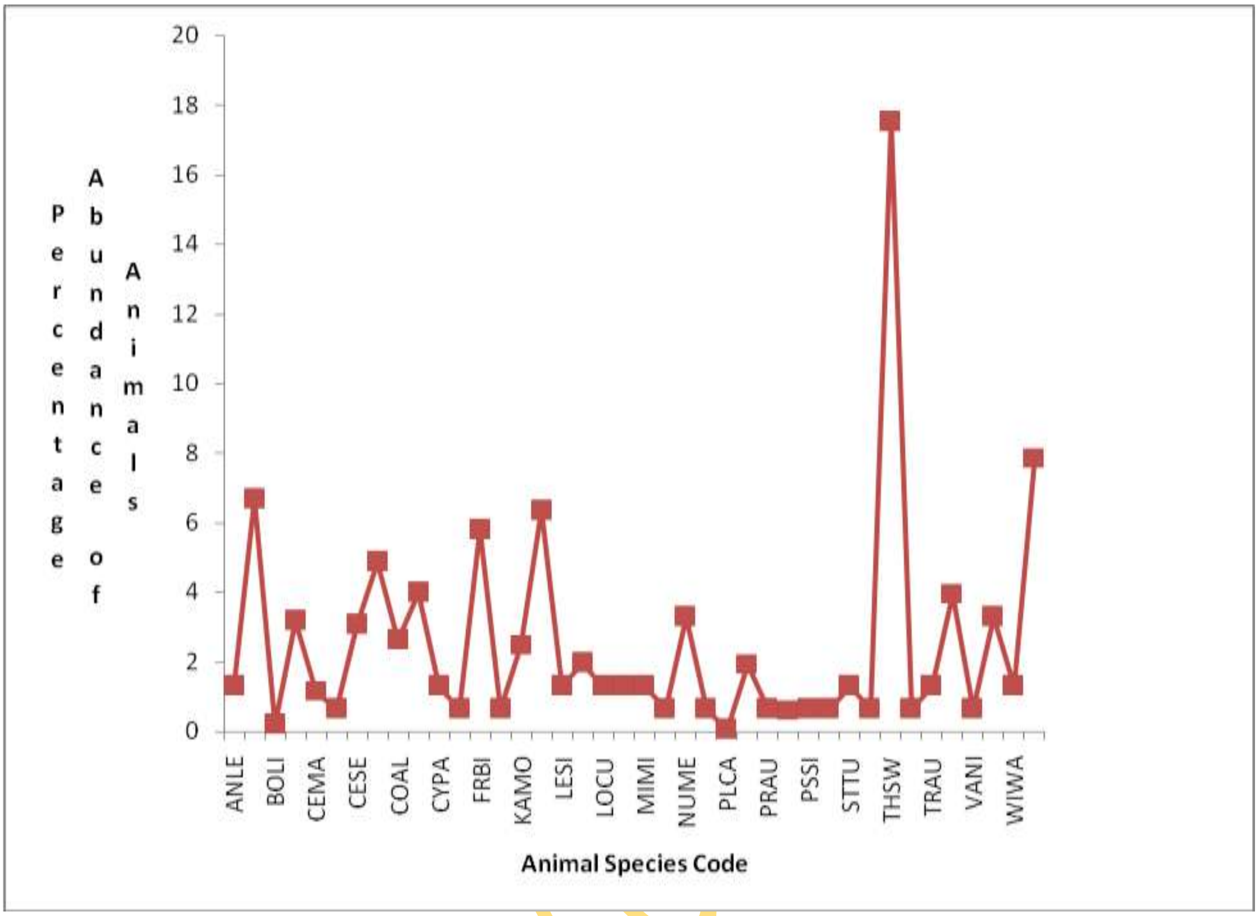

Fig. 8: Percentage Average Abundance of Animals in the Study Area

Source: Field Survey (2005 - 2008)

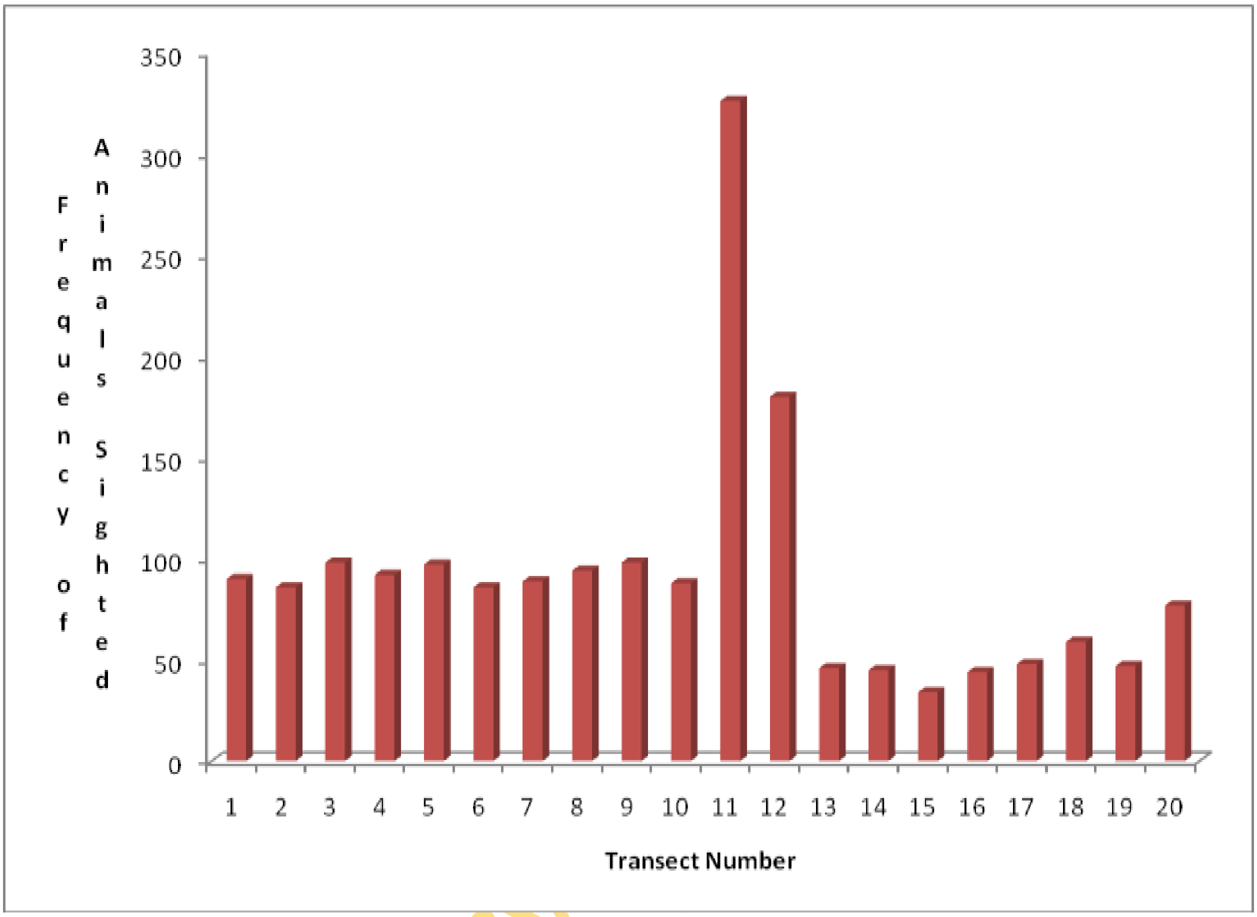

Fig.9 : Average Frequency of Animals Sighted in the Study Area

Source: Field Survey (2005 – 2008)

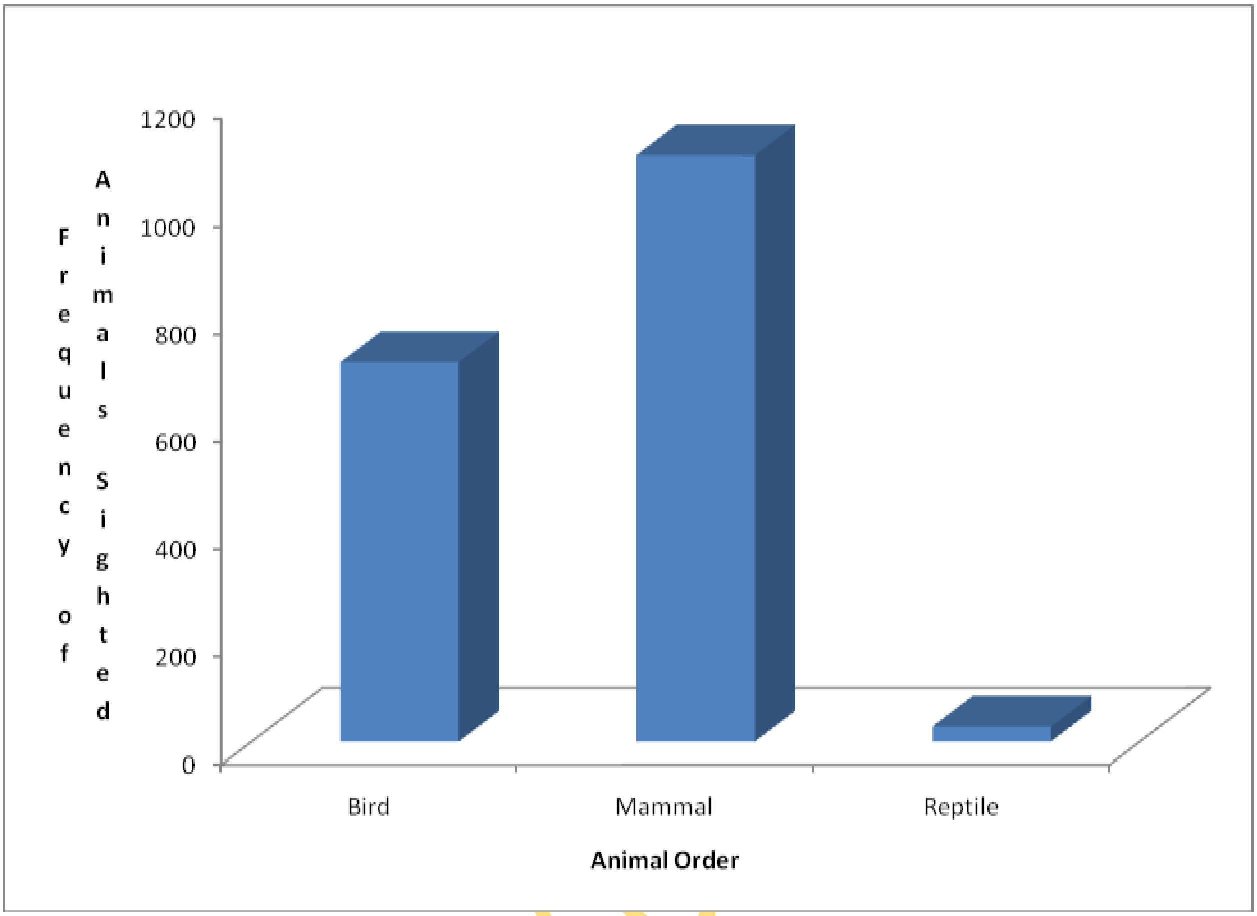

Fig. 10: Order of Animals Sighted in the Study Area

Source: Field Survey (2005 – 2008)

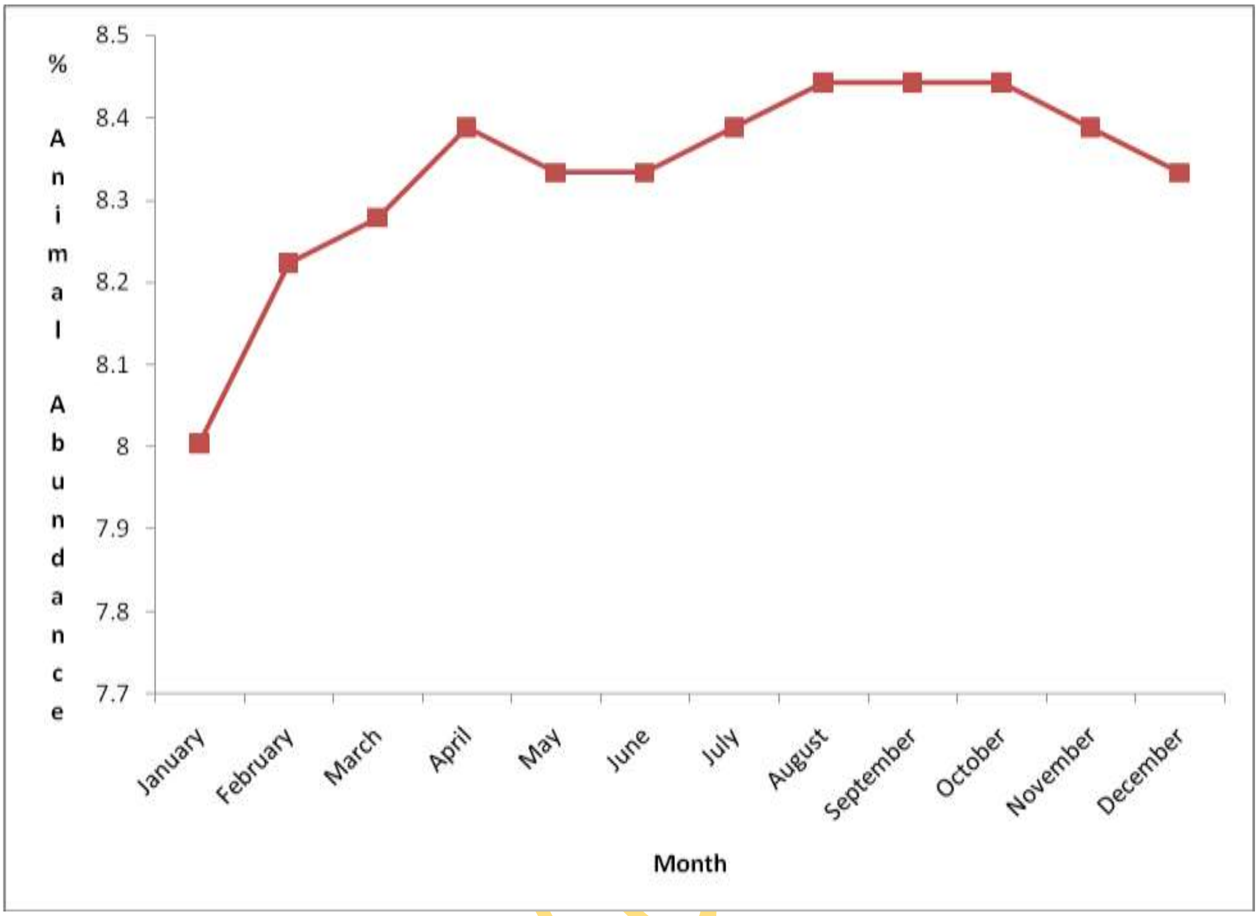

Fig. 11: Percentage Average Monthly Animal Abundance in the Study Area

Source: Field Survey (2005 – 2008)

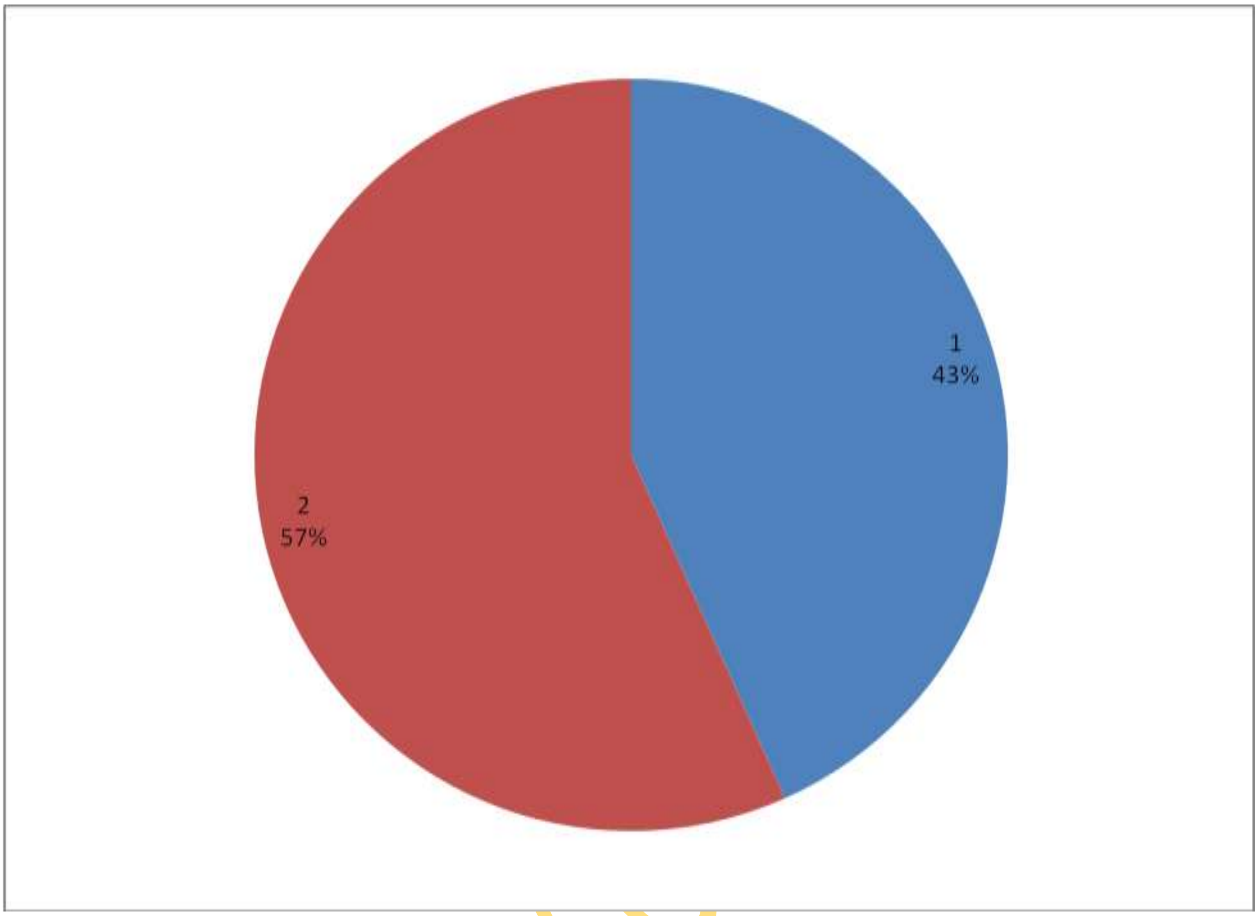

Fig. 12: Animal Sighting Indicator of the Study Area

Source: Field Survey (2005 – 2008)

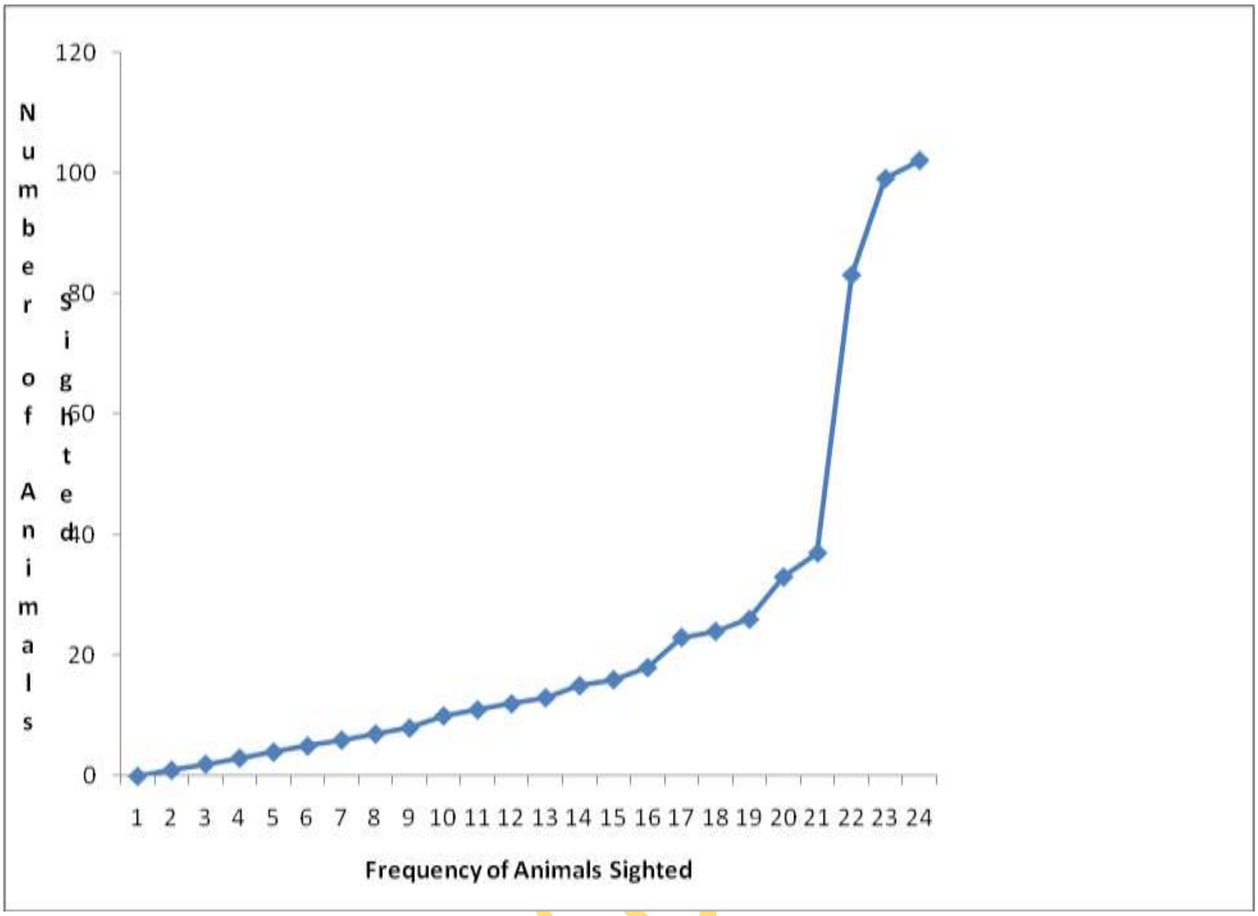

Fig. 13: Average Animals Sighted in the Rainy Season in the Study Area

Source: Field Survey (2005 – 2008)

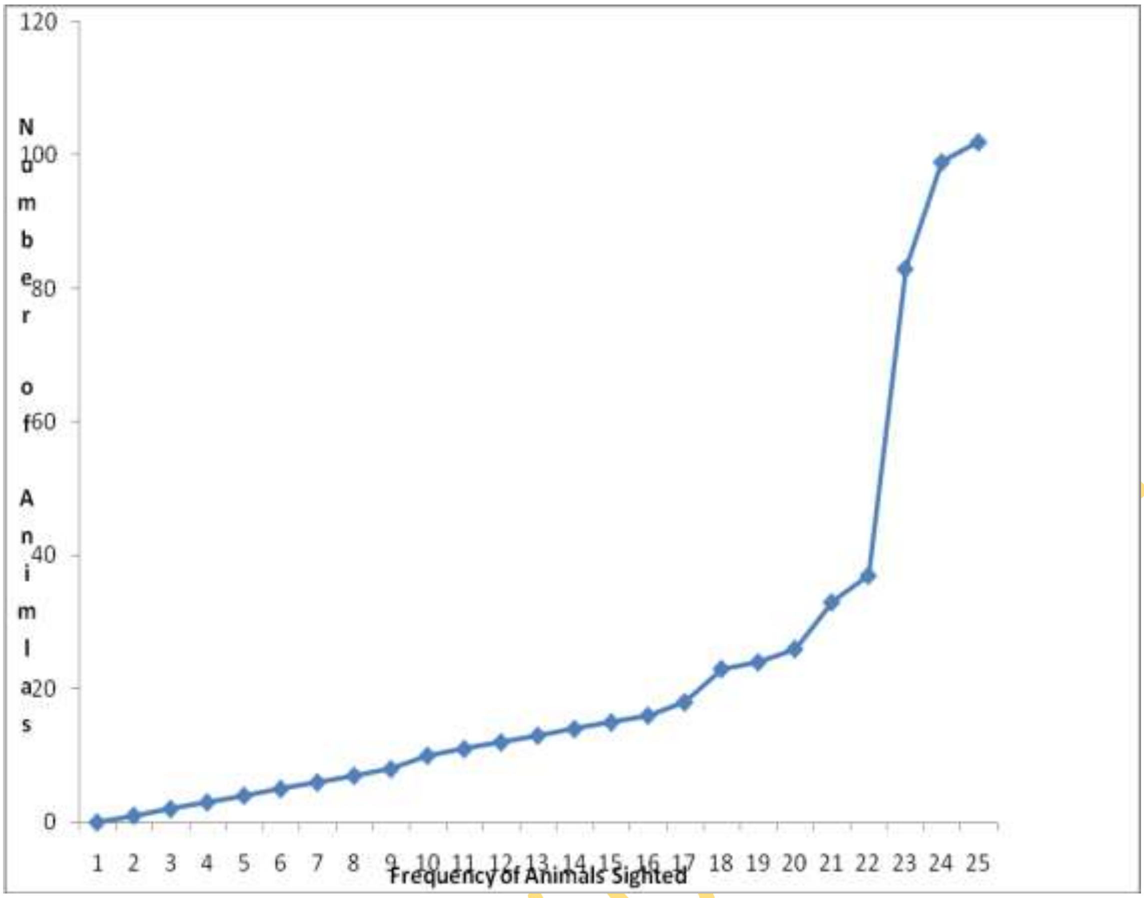

Fig. 14: Average Animals Sighted in the Dry Season in the Study Area

Source: Field Survey (2005 – 2008)

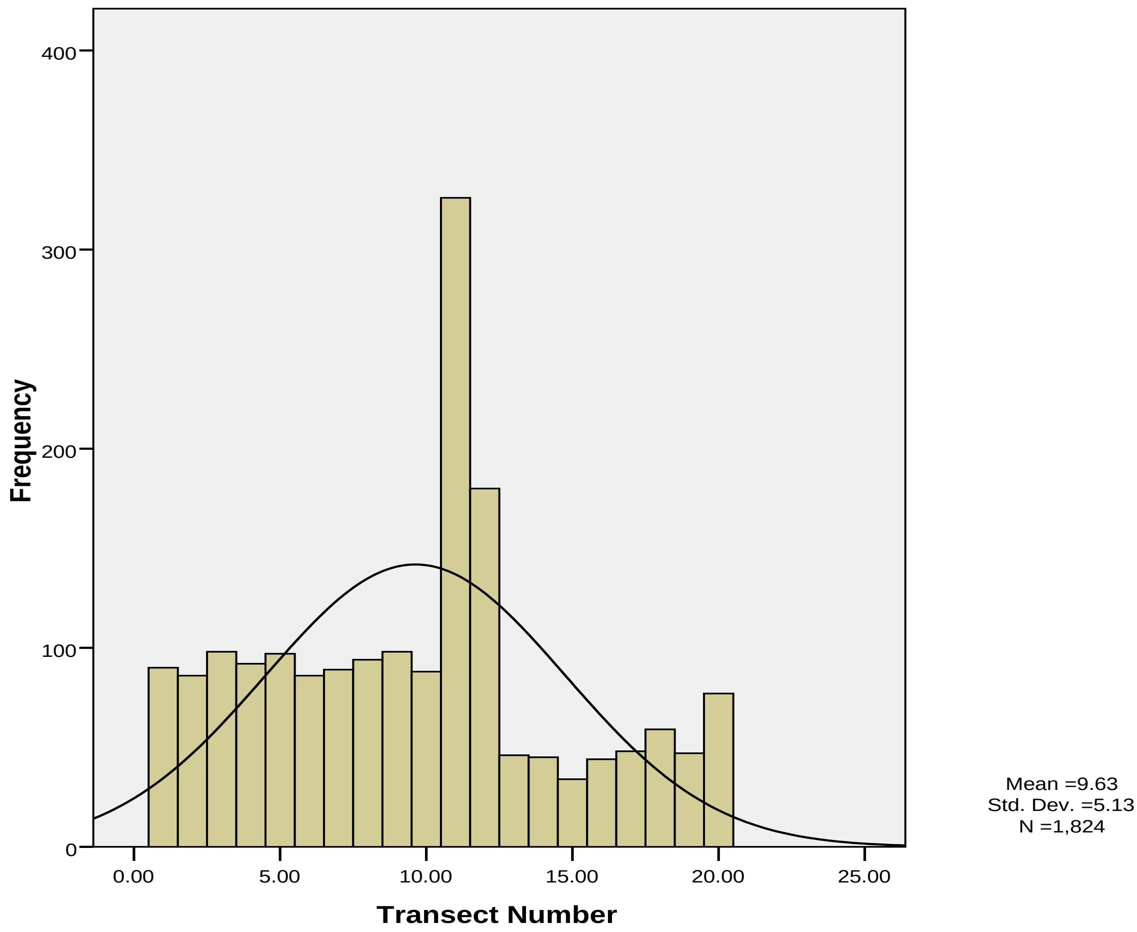

Fig. 15: Average Frequency of Animals along Transects in the Study Area

Source: Field Study (2005 – 2008)

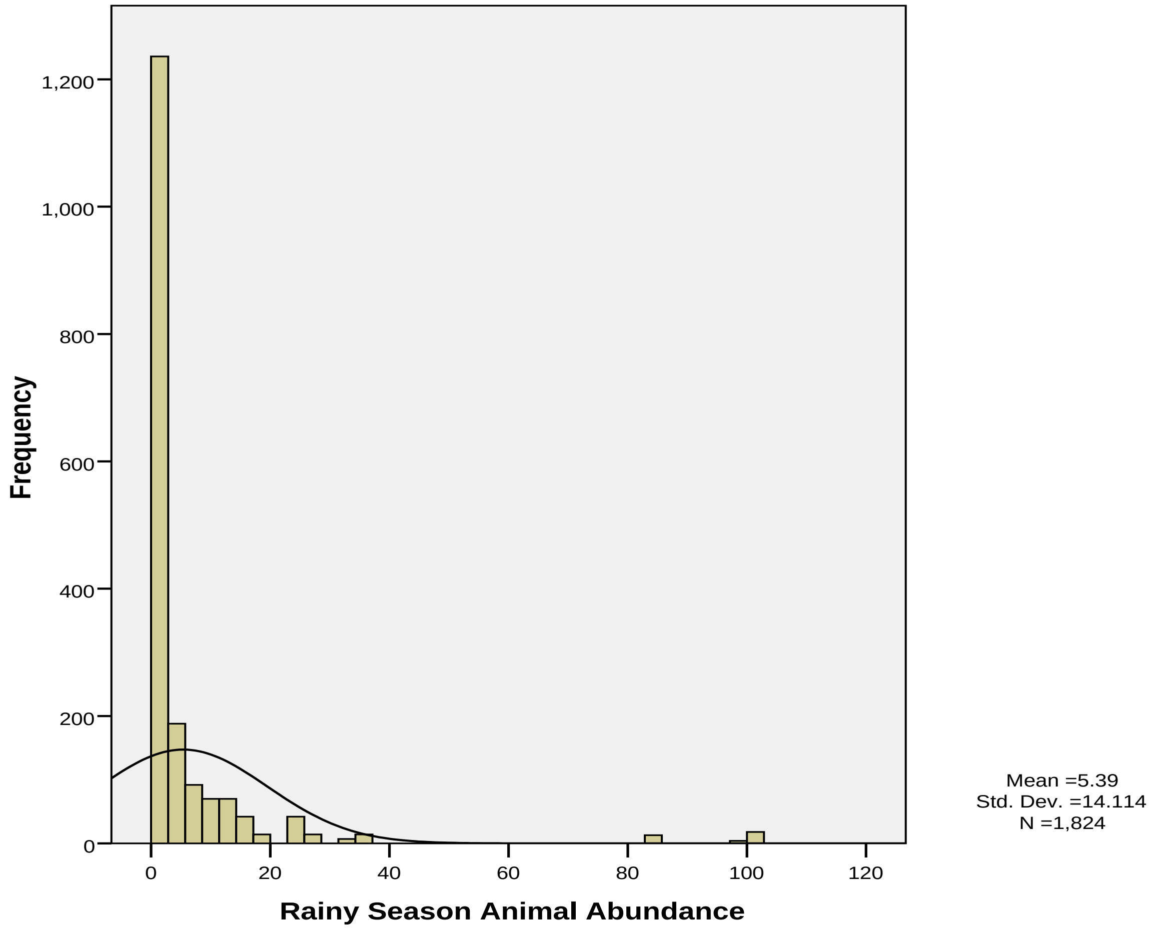

Fig. 16 Average Rainy Season Abundance of Animals in the Study Area

Source: Field Survey (2005 – 2008)

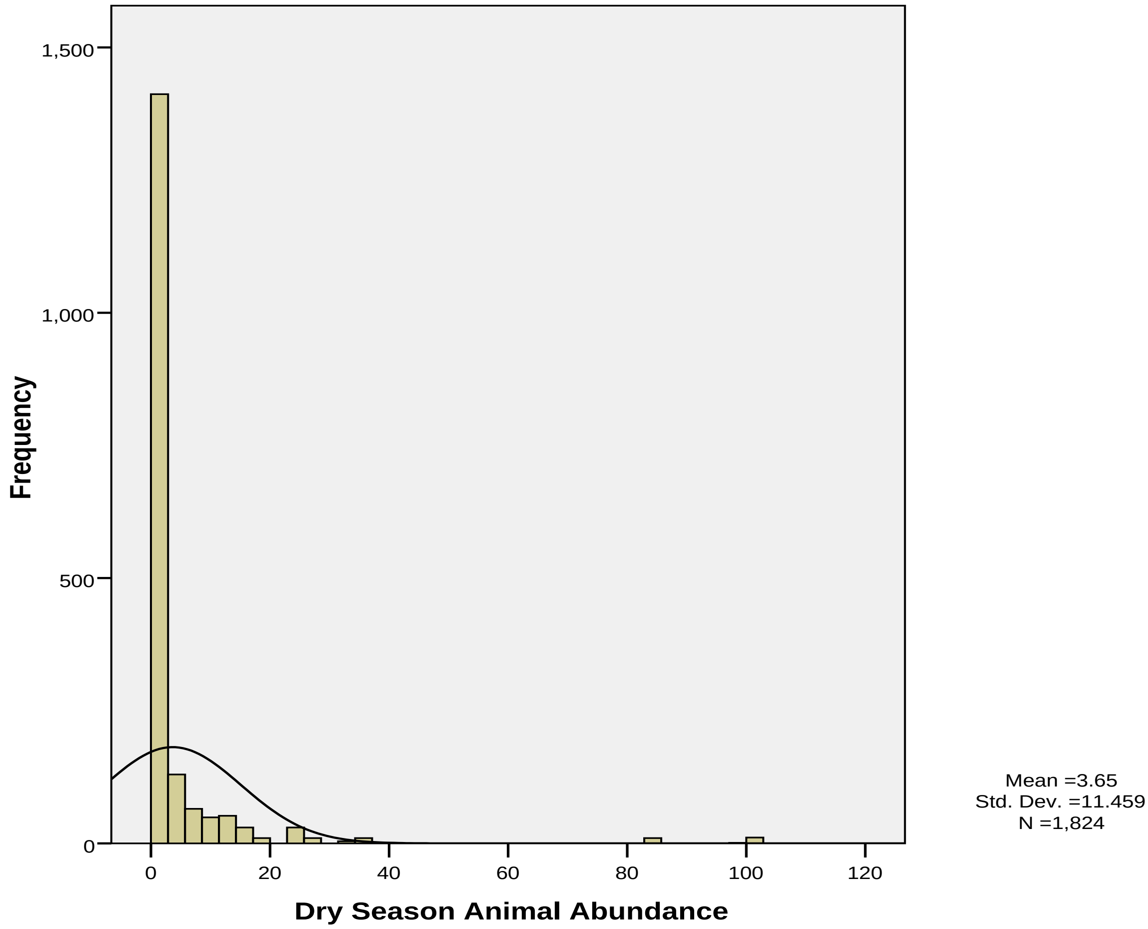

Fig. 17: Average Dry Season Abundance of Animals in the Study Area

Source: Field Survey (2005 – 2008)

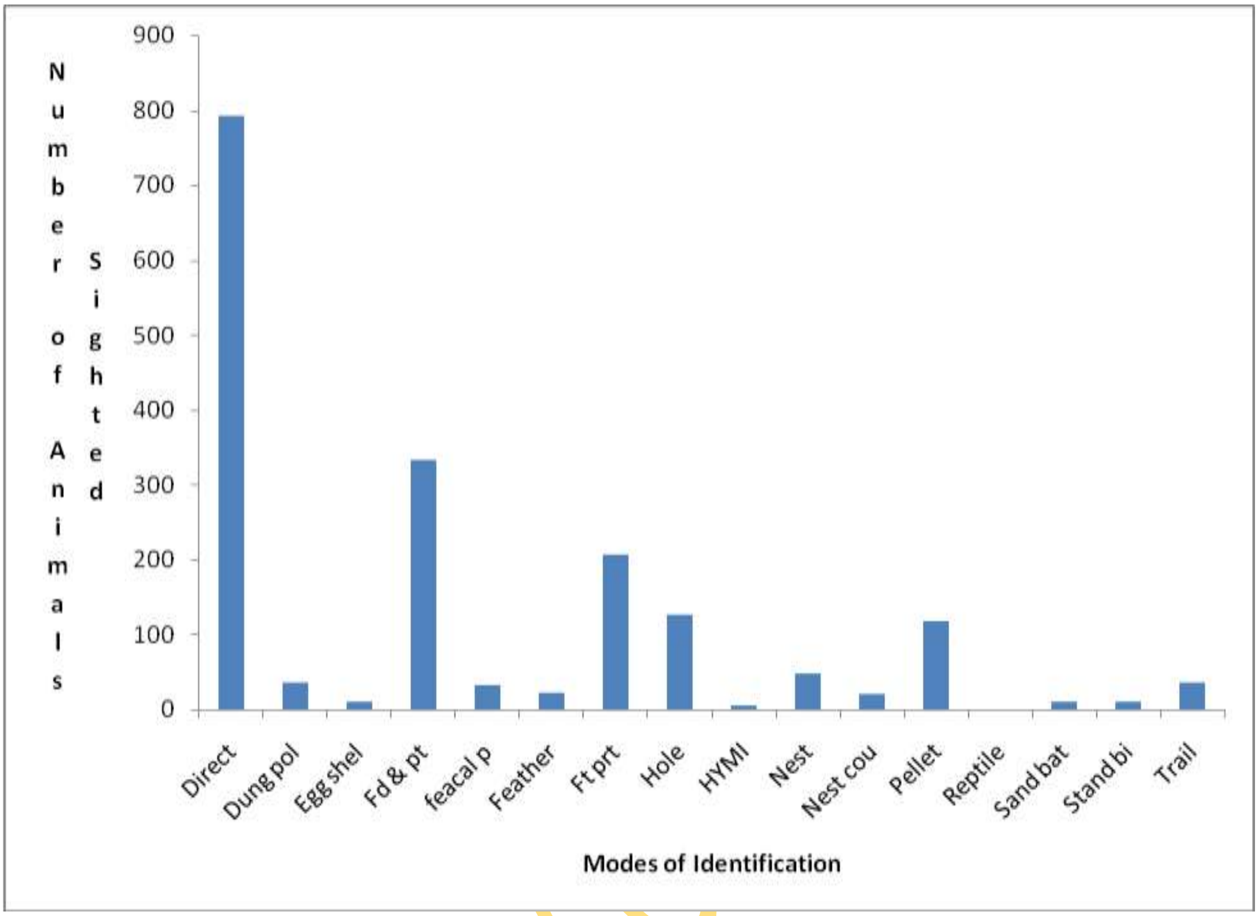

Fig. 18: Modes of Animal Identification in the Study Area

Source: Field Survey (2005 – 2008)

4.3 SOIL ANALYSIS

Table 11 shows the pH, percentage Carbon, percentage Nitrogen, percentage Organic matter, Silt and Sand of the various plots in the study area. Plot 3 has the most Orgaic matter with while polts 2, 6 and 7 had the least with 13.07 percent. The pH of the plots were almost constant ranging between 5.18 and 6.62

Table 11: Soil characteristics parameter of the study site

Plot	pH	Percentage Carbon	Percentage Nitrogen	Percentage Organic Matter	Clay	Silt	Sand
1	6.11	36.31	3.63	62.60	4.00	4.80	90.40
2	6.12	7.58	0.78	13.07	4.80	4.80	83.20
3	5.66	40.30	4.03	69.48	9.60	7.20	89.60
4	6.10	38.52	3.85	66.41	4.80	8.80	87.20
5	6.15	35.11	3.51	60.53	4.80	8.80	89.60
6	5.37	7.58	0.76	13.07	7.20	3.20	90.40
7	5.64	7.58	0.76	13.07	4.80	4.80	78.29
8	6.30	75.01	7.50	19.32	9.14	12.57	87.20
9	5.85	25.94	2.59	44.71	5.60	7.20	84.00
10	5.72	12.77	1.28	22.01	8.80	7.20	84.80
11	5.41	55.06	5.51	94.93	5.60	9.60	82.40
12	5.18	61.85	6.18	16.62	5.60	12.00	88.80
13	6.29	23.14	2.31	39.90	4.80	6.40	47.20
14	6.16	15.56	1.56	26.83	5.60	47.20	69.60
15	6.16	33.12	3.31	57.09	4.80	25.60	90.40
16	5.93	12.77	1.28	22.01	4.80	4.80	90.40
17	6.62	26.73	2.67	46.09	5.60	4.00	86.40
18	6.29	38.70	3.87	66.72	5.60	8.00	89.60
19	5.61	9.98	0.99	17.20	4.80	5.60	89.60
20	5.60	11.57	1.20	20.64	5.60	4.80	89.60

Source: Field Survey (2005 – 2008)

4.4 DIVERSITY INDICES, ANALYSIS OF VARIANCE AND CORRELATION

The Animal and plant diversity indices are shown in tables 23 and 24 respectively. The rainy season plant analysis of variance at $p = 0.05$ was 0.2579 and 0.0005266 for the dry season. The plants were positive and significantly correlated $r = 0.96661$ ($p = 0.05$).

Table 12: Animal Diversity Indices of the Study Area

INDICES	RAINY SEASON	DRY SEASON
Dominance_D	0.004305	0.005938
Shannon_H	**0.6065**	**0.5741**
Simpson_1-D	**0.9957**	**0.9941**
Evenness_e^H/S	0.4016	0.4162
Equitability_J	0.8692	0.8675
Fisher_alpha	0.3063	0.2162
Berger-Parker	0.01037	0.01531

Source: Field Survey (2005 – 2007)

Table 13: Plant Diversity Indices of the Study Area

INDICES	RAINY SEASON	DRY SEASON
Dominance_D	0.005534	0.005032
Shannon_H	**0.6308**	**0.625**
Simpson_1-D	**0.9945**	**0.995**
Evenness_e^H/S	0.5137	0.5503
Equitability_J	0.9045	0.9128
Fisher_alpha	0.7905	0.6797
Berger-Parker	0.02653	0.02458

Source: Field Survey (2005 – 2008)

Table 14: Problems confronting the Nature Reserve based on respondents observation

Problem	Percentage
Burning	46
Development	-
Farming	-
Hunting	20
Grazing	34

Source: Field Survey (2005 – 2008)

Table 15: Means of meteorological Observations of the Study Area (2005 -2008)

Parameter	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC
MEAN TEMP ^{O}C	2.03	29.17	28.63	29.33	23.87	22.97	26.4	25.77	26.00	27.38	28.48	28.05
RAINFALL(mm)	1.51	20.67	24.43	65.03	29.2	98.3	41.77	25.07	91.37	25.25	14.57	4.51
REL.HUMUDITY(%)	6.13	71.13	73.33	70.40	69.07	68.73	85.53	85.73	85.93	82.37	77.07	70.37
WIND RUN (Km/Day)	22.09	9.28	9.28	15.53	5.49	5.54	5.96	6.54	4.13	1.45	0.96	1.38
SUNSHINE DURATION(Hrs)	1.28	2.42	1.92	1.73	6.07	2.56	2.06	0.77	1.08	1.17	1.09	1.41

Source: Department of Agro Meteorology UNAAB

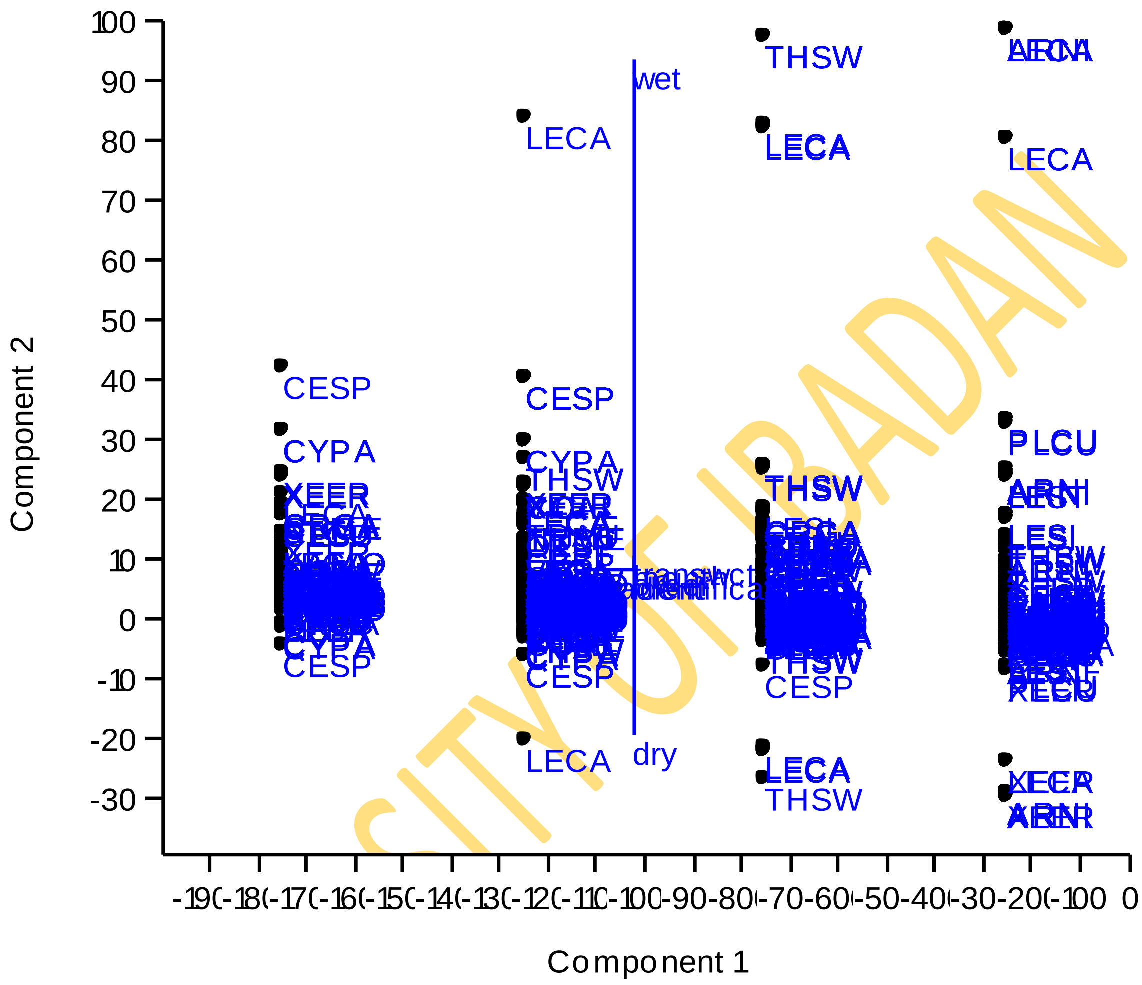

Fig.19: Principal Component Analysis of the distribution of Animals species encountered in the Study Area.

Source: (Field Survey 2005 – 2008)

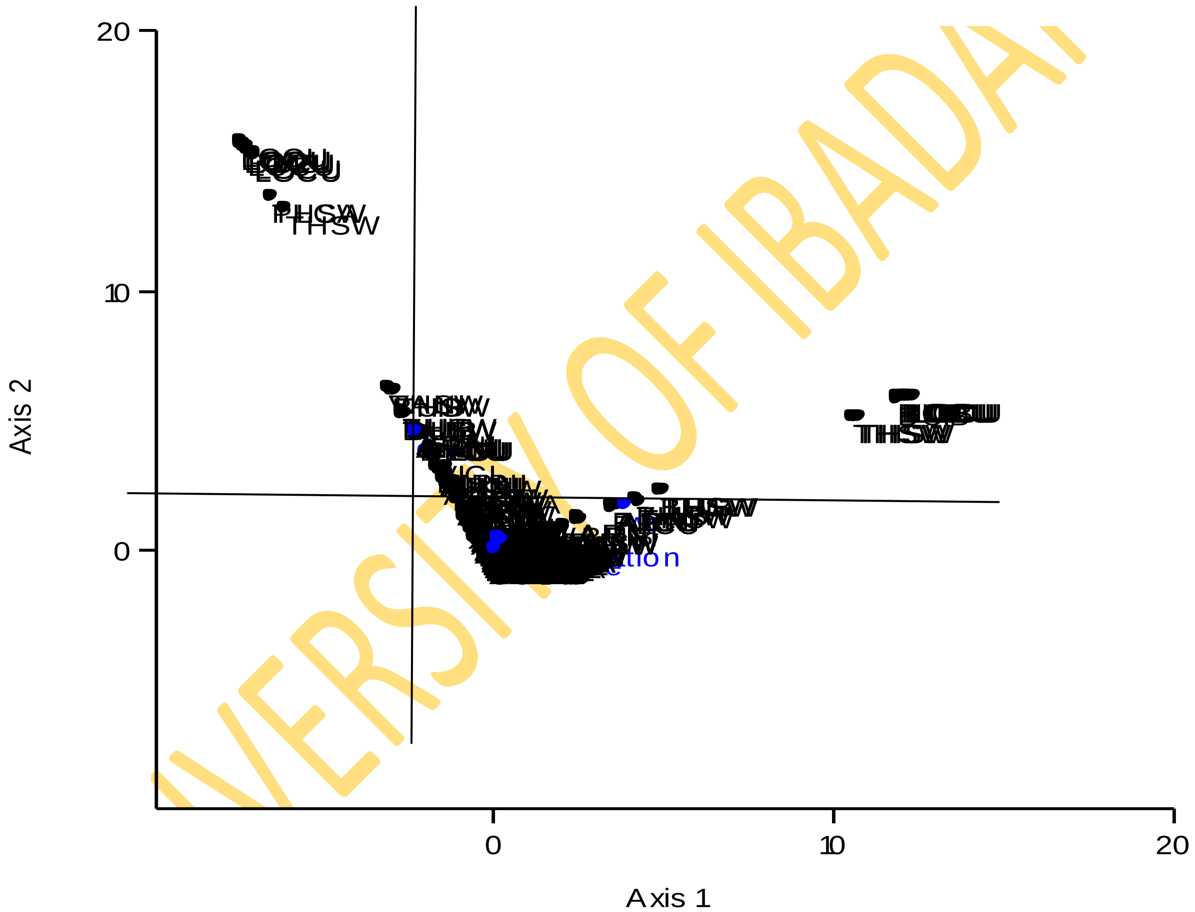

Fig.20: Ordination Diagram of Animals in the Study Area

Source: (Field Survey 2005 – 2008)

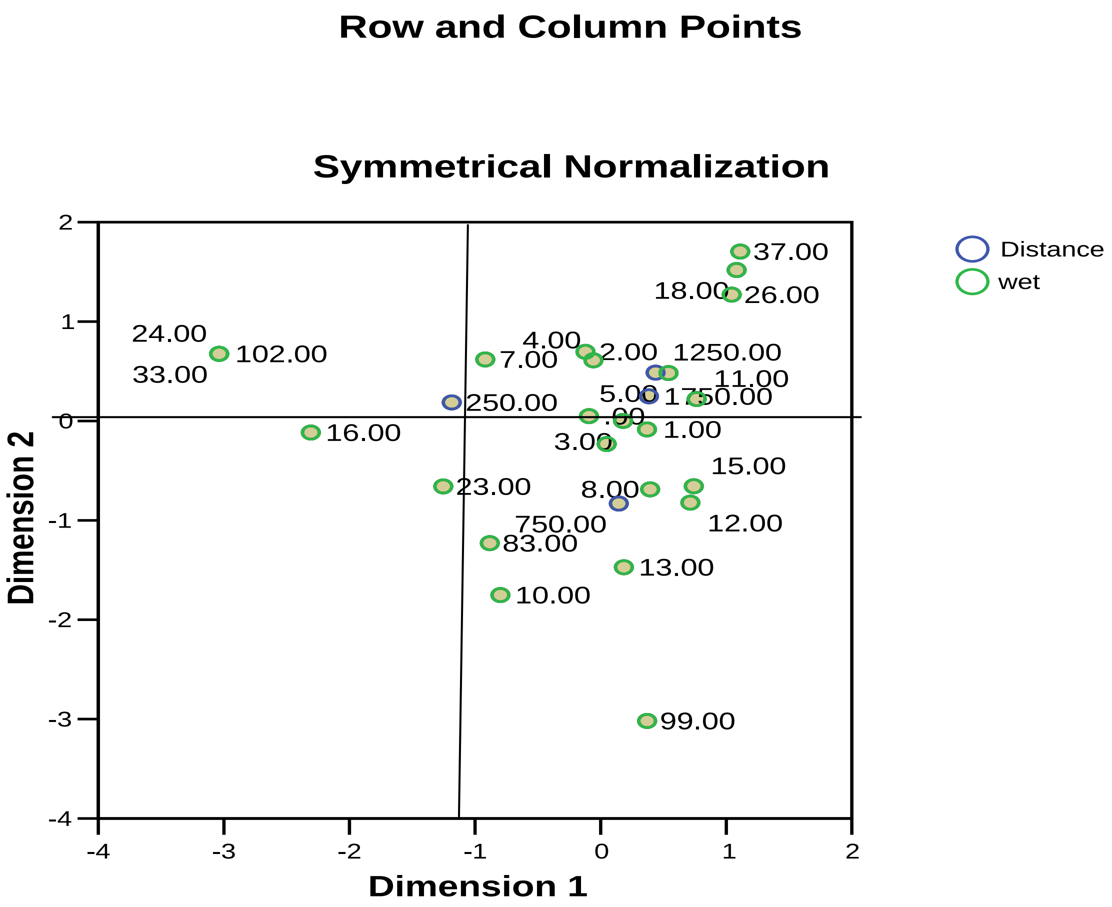

Fig.21: Sighting of Animals According to Distance from Transects in the Wet Season

Source: (Field Survey 2005 – 2008)

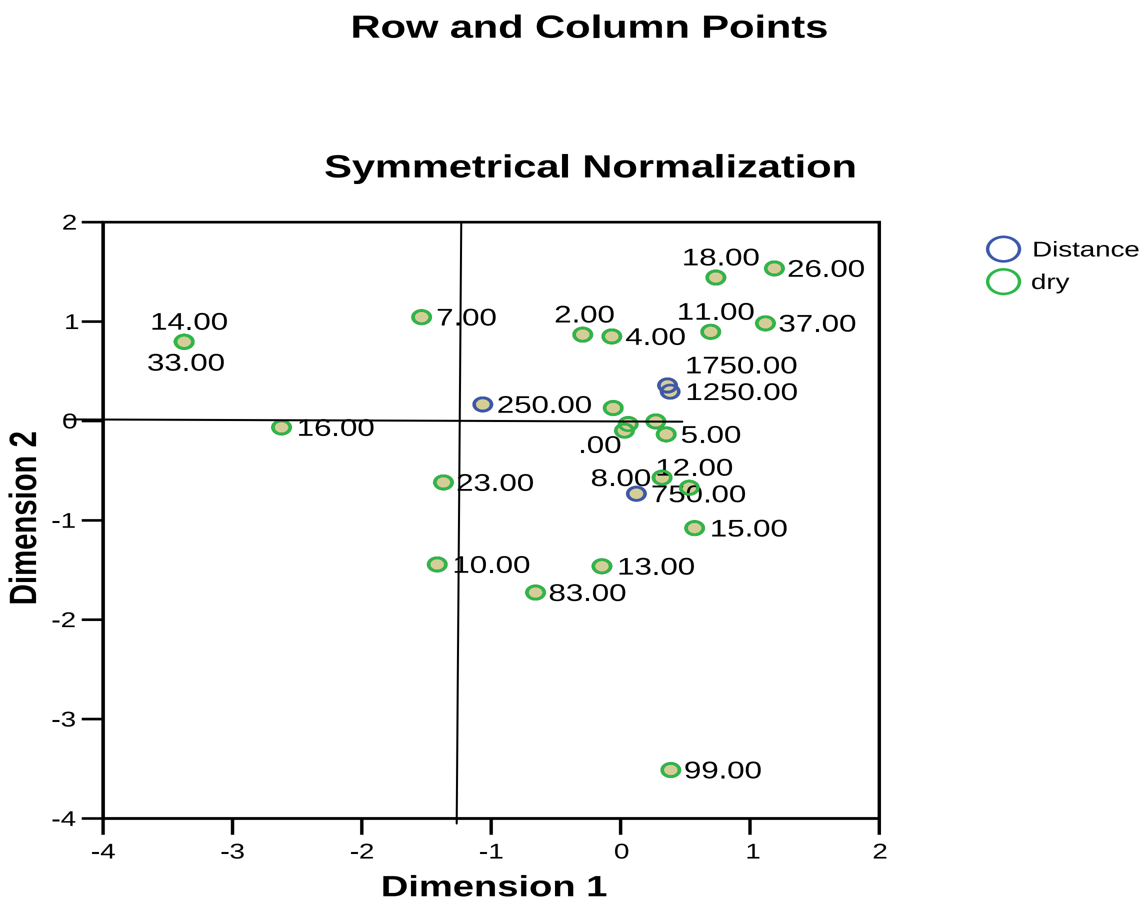

Fig.22: Sighting of Animals According to Distance from Transects in the Dry Season

Source: (Field Survey 2005 – 2008)

CHAPTER FIVE

5.0 DISCUSSION

5.1 Discussion

5.11 Species Diversity, Component Analysis

The level of species diversity recorded for plants and animals in the study area is high; one hundred and eighteen (118) plant species from 44 families and 40 animal species from 31 families. According to Richards (1952), the humid tropical forest has the richest and most heterogeneous faunal and floristic diversity which developed largely because of the favourable conditions of climate and other factors that favours the abundance of species in all seasons. The study area has the diversity of plants recorded because it is free from hunting pressures, thus serving as a refuge for the animals. Onadeko and Meduna (1985) reported abundance of animals in the protected sites than sites that were unprotected. Also the high plant species diversity recorded in the study area can be attributed to the absence of agricultural practices and other development activities. Grasscutters and Giant rats were most abundant in the study area because there were favourable food resources as well as cover adequate for their requirments were present.

The results of this study indicate that *Daniella oliveri, Anona senegalensis, Bridelia micrantha* and *Ficus capenssis* were the most abundant tree species. According to Kupchella et al (1993), the edaphic, climatic and topographic factors determine the type and distribution of plant species that will survive in an area. The plants in turn control these factors and create a microclimate that ensures a normal physical environment that promotes their survival. Happold (1987), also reported that in certain cases, the animals present in a vegetation could be a major determinant of the type of vegetation that will persist in an area because of their mode of utilization of the plants for food and cover. Therefore, the relationship that exists between most of the plants and animals indicated by the biplots promotes a stable ecological system for their survival.

Animals in the order rodentia, especially Cane rat (*Thryonomys swinderianus*), Giant rat (*Cricetomys gambianus*) and Ground squirrel (*Xerus erythropus*) were the most abundant in the study area. Indices of their activities include feeding remains, droppings and burrows.

The Maxwell duiker (*Cephalopus maxwelli*) was also recorded in appreciable portion. Happold (1973) and Roberts (1986) stated that the trophic ecology and need for protection against predators of animal species in an area explains basis for their habitat distribution.

Dasmann (1985) and Onadeko (1995) also reported that the availability of food, water and cover are the major determinants of wild animal occurrence and distribution in an area. This explains the distributions of animals on the biplot based on their feeding and cover requirements.

The Cane rats were predominant in areas with dense grasses and rampant herbaceous vegetation where there is also good cover. They feed on thick stemmed grasses and occasionally on tree barks (Happold, 1987) as shown by their runways, feacal droppings and feeding remains. The Giant rat (*Cricetomys gambianus*) feed on fruits, vegetables, seeds, maize, yams, and oil palm nuts and this explains their abundance because some of these requirements are in abundant supply in the study area.

Also, the Ground squirrel, found widely in the study area live habitually on the ground especially in burrows and feed on seeds, roots and bulbs (Ewer, 1969). The areas were they are mostly found in the study area is rich in these requirements. The Maxwell duiker lives in wooded and grassland savanna where there are small thickets and undergrowth where they can seek cover (Happold, 1973). Their diet consists of leaves and herbs and young plant. These food and cover requirements abound in the study area where they browse on the young stems of these trees and shrubs and hide in the dense undergrowth.

The Hares (*Lepus capensis*) live in drier habitats where the vegetation is heavily grazed and grasses are short and spouting (Happold, 1987). They are found to predominate in such vegetation on the study site. This habitat preference causes them to live in areas otherwise uninhabitable for other browsers and grazers and explains the large dispersion of their position on the northern portion of the study site where they occur away from the other wildlife species occurring in the dense wooded vegetation at the southern part of the study site.

The Principal component analysis (fig. 19) and Ordination (fig. 20) shows that the ecosystem of the study site is not stable yet. This can be observed from the clustering of the animal species together in an attempt to make the best use of the environment. This may be due to the fact that the Strict Nature Reserve is recently demarcated and requires some time to settle away from the previous land use pattern of the area. The bulk of animal species wthin transects, combed during the survey were encountered during the dry season, while few were encountered during the wet season. Along the transects, gradients, distribution of most of the species were closely tied to the season and are related either in the movement or other activity pattern, but some other also show a wide dispersion from the effect of the major component i.e dry season. Animals such as *Cephalopus spesies*, *Lepus capensis*, some *Arvicauthus niloticus* and *Thryonomys swinderianus* are in this group. These were found at the extremes of dry and wet season within the space.

Ordination of animal species distribution in transects and season revealed that the gradation is discontinuous but concentrated in the ordination space at around 12.0'clock and 3.0'clock and between 9-12 0'clock again. What this translates into is that every animal species that are found within the same quarter space are close and have almost the same factors influencing their distribution. Within the same quarter it was also noticed that *Lonchura cucullata* and *Thryonomys swinderianus* are closer and a bit separated from the bulk, thus it can be suspected that a kind of ecological or biological relationship is occurring between them. Relationship between the animal species and environmental variables measured (seasons) indicate a very strong association between the factors and animal species thus, distribution, performance and survival of the species may be directly influenced by these variables.

Gradient distribution of animal species in wet season indicative of the point of contact with the animal along the transect gradient as well as the abundance values of the animal species encountered. The least abundance value of animal species (5.0) was encountered within the quadrant 1750 while the highest (102) was found in quadrant 250, so also in the dry season, the least (11.00) was encountered in quadrant 1750 but the highest abundance of (99.00) was found within 750 gradient.

The disappearance of many plant species due to human activities is depleting the world's genetic resources and is putting man's heritage of biodiversity under serious threat. There is therefore the urgent need to preserve genetic diversity including plant resources of known and unknown economic importance which will guarantee the availability of all potentials for use in the benefit of our children and grandchildren (Olowokudejo, 1987). The human race in their quest for economic development and improvement of their conditions of life must come to terms with the realities of resource limitations and the carrying capacity of ecosystem must also take account of the needs of future generation. This is the central message to modern conservation. Biological diversity must be treated seriously as a global resource, be indexed, used and above all preserved. Three circumstances make it imperative for this to be given an unprecedented urgency particularly in West Africa. Firstly, exploding human populations are seriously region. Secondly, science is discovering new uses for degrading the environment at an alarming rate in the sub biological diversity in ways that relieve both human suffering and environmental destruction. Thirdly, much of the diversity is being irreversibly lost through extinction caused by the destruction of natural habitats, which occurs more in Africa than elsewhere (Wilson, 1988). Dasman et al., (1973) agreed that forest exploitation leads to the extinction of animals and plants whose genetic resources are of considerable value to future generations (Round Table, 1969). Forest depletion has destabilized the natural environment and eroded genetic resources throughout the southern part of Nigeria in order to meet the sustenance of the population and financial requirements of government i.e. the social, economic, demographic and political needs of the people. Exploitation of forests therefore appears to be split about vegetation depletion which is considered as a inevitable considering the above. Opinions are however loss of natural heritage. According to some scientists (Harvey and Hallet, 1977) it may not be beneficial to conserve resources for future generation at all costs because the future demands, aspirations, lifestyles and needs of rural people cannot be adequately defined now. Must we then wait for the needs to be defined before we conserve? Definitely not, because all of these genetic resources would have disappeared before the needs are identified. As such, conservation is basic to human welfare and indeed to human survival (Allen, 1980). Lack of conservation measures will amount to an increase in the number of endangered species and this will ultimately result in extinction, which is the gradual but sure elimination of taxa (Allaby, 1998). Many of the species that are already endangered are faced with the risk of eventual extinction if human activities such as land development, logging and pollution are not checked. Gbile et al. (1981, 1984) revealed that about four hundred and eighty plant species of the Nigerian flora have been described as endangered or rare, out of which many of these are being studied at the Forestry Research Institute of Nigeria, Ibadan. Apart from the gradual loss of biodiversity, the devastating environmental disasters in urban and rural areas of Nigeria indicate that these environments are under stress and require urgent intervention (Oguntala, 1993). While developmental activities continue on the campus it will be a sound scientific judgment to protect a representative sample of vegetation for posterity, hence the idea of the idea of UNAAB Strict nature Reaserve. This is the practice in most developed countries of the world. The Omo Biosphere Reserve and the International Institute for Tropical Agriculture (IITA) at Ibadan, Nigeria has such an area which now serves as an example of a typical tropical Rain forest in south Western Nigeria.

Burning from wild fire is the greatest problem being faced by the Nature Reserve according to respondents (Table 25), making up 46% of problems confronting the site. Another big problem is the illegal grazing by nomadic Fulani herds men that have settled around Opeji (a town close to the Alabata area), these herds men are traditionally difficult and stubborn, but they are being engaged through there leaders. Hunting is minimal at 20% according to respondents and this may be due to conservation awareness among the settlers around the nature Reserve emanating from the efforts of the Department of Forestry and Wildlife Management of the University field staff.

5.12 Soil structure, texture and chemical composition

The structure, texture, consistence and chemical composition of the soil determine the type of plants and consequently the animals it will support (Russell, 1957; Happold, 1973). These are the factors that determine the fertility of any soil. (Forth, 1978), explains that the humus and clay contents of soil dictates its ability to absorbs and retain nutrients. The sandy-loam soil of the study area has an appreciable proportion of organic matter and clay. According to Bohn *et al* (1979), the pH of a soil determines the percentage composition of organic matter in it. Soil with high pH value allows a high microbial activity hence, increasing biological degradation (Brady, 1974). Also, a highly leached soil allows high mineral synthesis and hence, high clay content. The leached soil of the study area containing plenty organic matter and having a high pH value supports a large proportion of plant species (Table 11).

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Many scholars and some multinational organizations such as the World Bank, which have long linked high population growth with poverty and underdevelopment, have now turned their attention to uncovering linkage between population and environmental degradation. According to World Bank (1992), rapidly growing populations have led to "overgrazing, deforestation, depletion of water resources and loss of natural habitat". In a separate report, the World Resources Institute, IUCN- the World Conservation Union, and the United Nations Environmental Programme also identified "unsustainable high rates of human Population growth and natural resources consumption" as the first of the six fundamental causes of biodiversity loss (IUCN/UNEP/WWF 1992)

The maintenance of a healthy ecosystem is largely dependent on its management and control of activities of man and animals. Human interference such as hunting, grazing, farming, bush burning and clearing for construction and development of physical facilities will influence survival and relative abundance of plant and animal species available in an area.

Climate change with is attendant effect on temperature levels and pattern of rainfall will also determine the survival of wildlife in a given area. Because the rate at which the climate is changing makes it difficult for biodiversity to adapt, as temperatures keeps changing with time.

The stability of the soil is also determined largely by these activities. It is therefore expedient to consciously manage the plants, animals and soil components of the study site and their complex interactions to ensure a healthy environment.

6.2 Recommendation

The strict nature reserve should be managed on an environmentally sound sustainable principle. The incidence of annual fire that currently ravages the area should be reduced drastically. This would enable the ecosystem of the study site to stabilize.

There should be continuous awareness education on the Strict Nature Reserve, by means of awareness campaigns conducted through the mass media and also organized talks, film shows and seminars, so that more reverence would be accorded the site.

Establish a data-base to show the diversity, distribution and status of biological diversities (both flora and fauna) in the study area.

There should be employment of dedicated security to enforce the entrance law of the site, the arrangement of overseeing the area by the existing University Security has proved to be inadequate.

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APPENDIX 1

DEPARTMENT OF WILDLIFE AND FISHERIES MANAGEMENT
FACULTY OF AGRICULTURE AND FORESTRY
UNIVERSITY OF IBADAN,IBADAN

WILDLIFE RESEARCH QUESTIONAIRE IN SOME SELECTED EXTENSION VILLAGES AROUND UNAAB, ABEOKUTA

1Name of village 2Location of village

3Estimated Population size of village/settlement

4 Name of respondent

5 Age group of respondent
(a) 10-20years
(b) 21-30years
(c) 31-40years
(d) 41-50years
(e) above 50years

6 Marital statuses: Single/ Married 7 Sex: male/female

8 Household Sizes
No of wife(s) No of Children

9 Nationality 10 State of origin

11Occupation
(a)farming (b)hunting (c)trading (d)farming+hunting

(e)government or paid employment (f) others

12Mention your major source of income

13How many years of experience
(a) as a farmer
(b) as an Hunter
© as a trader
(d) as a paid worker

14 Highest Educational statuses obtained
(a) No formal school attended
(b) primary school
© Secondary school
(d) tertiary institution
(e) others (specify)

15 What motivated you into hunting

16 What motivated you into farming

17 What motivated you into trading

18What are the method(s) of hunting that you use

(a) Traps List types
(b) Dogs
(c)Chasing
(d) traditional (describe)
(e) Fire
(f)sole hunting (g) group hunting

19 What types of weapons do you hunt with

(a) modern firearms
(b) traditional firearms eg dane guns
© Cutlass
(d) combination of----------------------------and---------------------------------
(d) others

20 How do you get your weapons?

(a) Made by self
(b) Local purchase from blacksmith
© Local purchase from ready-made shop
(d) others

21 What animal species do you List species

(a) kill for sale only
(b) kill and eat only
© kill to sell part and consume part
(d) kill and you do not consume why?----------------

22 Around where do you hunt?

23 When do you prefer to hunt

(a) season
(b) time of day
1 early morning
2 afternoons
3 late evening
(c) night

24 What season do you kill more animals:

(a) rainy season
(b) dry season
(c) full moon
(d) half moon
(e) no moon

25 List types of Animals hunted

26 Is there any laws that guide the hunting operation?

27 What is the distance of your hunting site from home (approximate km)

28 In What type of vegetation do you prefer to hunt

(a) On my farm
(b) In the natural bush
© Anywhere

29 topography of the area
(a) rocky outcrop animals mostly found
(b) Flat terrain animals mostly found
© Wetland(riparian) animals mostly found

30 Average no of wildlife SPECIES (types) hunted/day

31 How often do you see animals in the bush?
(a) during the day
(b) at night

32How are the animals sold?
(a) whole
(b) part
33 Selling price of hunted animals?
List (a) species selling price/whole animal

34 Who are your customers?
(a) Co-villagers
(b) civil servants
(c) Traders(buy and re-sell)
(d) Consumers (buy and consume)
(e) others
35 Does Government influence the prices? Yes/no

36 What animal species do people demand for

37 Why do they demand for such animals?
(a) price
(b) taste
38 Is there any taboo on
(a)consumption of any animal in the village What is the taboo? and list species affected
(b)killing of any in the village What is the taboo? and list species affected

39 Is there any protocol in sharing hunted animals.
(a) by group hunters
(b) by family members
(c) by villagers
40 If offered any other job, can you leave hunting?.

41 Do you belong to any farmers' association/cooperative? Yes/No
Name if Yes
If no why

42 Do you belong to any hunters' association/cooperative? Yes/No

Name if Yes

If no why

43 List benefits from your association/cooperatives

farmers' association/ cooperatives

hunters' association/ cooperatives

44 What type of crop(s) do you plant on your farm

45 Which crop(s) is(are) most affected by wildlife? List

46 Which Wildlife SPECIES attack your farm most.

Species	Crop and part affected

47 Problems encountered in carrying out

(a)hunting activities.

(b)farming activities

48Suggest what you will like done for you to encourage your hunting activities

49Suggest what you will like done for you to encourage your farming activities

Thank You.

APPENDIX 2

NAMES, CODE AND TAXONOMIC CHARACTERISTICS OF PLANT IN THE STUDY AREA

Couplet No	Scientific Name	Code	Family Name	Form
1	*Abelmoschus esculentus*	ABES	Malvaceae	Shrub
2	*Abrus precatorius*	ABPR	Papillionaceae	Climber
3	*Abutilon*	ABMA	Malvaceae	Shrub
4	*Acacia kamerunesis*	ACKA	Mimosaceae	Tree
5	*Acacia sieberina*	ACSI	Mimosaceae	Tree
6	*Acalyphyta ciliate*	ACCI	Malvaceae	Shrub
7	*Acanthospermum hispidum*	ACHI	Acanthaceae	Herb
8	*Acanthus montanus*	ACMO	Acanthaceae	Shrub
9	*Achyranthes aspera*	ACAS	Amaranthaceae	Herb
10	*Acridocarpus smeathhniamii*	ACSM	Malphishiaceae	Shrub
11	*Adansonia digitata*	ADDI	Bombacaceae	Tree
12	*Adenopus brevflorus*	ADBR	Apocynaceae	Climber
13	*Afromorsia laxiflora*	AFLA	Papillionaceae	Shrub
14	*Afzelia Africana*	AFAF	Caesalpinioideae	Tree
15	*Agelea oblique*	AGOB	Connaraceae	Shrub
16	*Agerantum conysoides*	AGCO	Asteraceae	Herb
17	*Albizia adianthifolia*	ALAD	Mimosoideae	Tree
18	*Albizia coriara*	ALCO	Mimosoideae	Tree
19	*Albizia feruginea*	ALFE	Mimosoideae	Tree
20	*Albizia zygia*	ALZY	Mimosoideae	Tree
21	*Albizia lebbeck*	ALLE	Mimosoideae	Tree
22	*Alchornea cordifolia*	ALCD	Euphorbiaceae	Shrub
23	*Alchornea laxiflora*	ALLA	Euphorbiaceae	Shrub
24	*Allophyllus africanus*	ALAF	Sapindaceae	Shrub
25	*Alstonia boonei*	ALBO	Apocynaceae	Tree
26	*Alstonia congensis*	ALCG	Apocynaceae	Tree
27	*Amaranthus spinosus*	AMSP	Amaranthaceae	Herb
28	*Amaranthus hybridis*	AMHY	Amaranthaceae	Herb
29	*Anarcardium occidentate*	ANOC	Anarcardiaceae	Tree

30	*Ananas comosus*	ANCO	Palmae	Shrub
31	*Aneilema beniniense*	ANBE	Commelinaceae	Climber
32	*Anchomamis difformis*	ANDI	Araceae	Herb
33	*Ancistrocapus densisipinosus*	ANDE	Tiliaceae	Shrub
34	*Andropogen gayanus*	ANGA	Poaceae	Grass
35	*Andropogen teetorum*	ANTE	Poaceae	Grass
36	*Anogeisus leiocarpus*	ANLE	Combretaceae	Tree
37	*Anona senegalensis*	ANSE	Annonaceae	Shrub
38	*Antana Africana*	ANAC	Mimosoideae	Shrub
39	*Anthocleista vogeillii*	ANVO	Loganiaceae	Shrub
40	*Anthocleista djalonesis*	ANDJ	Loganiaceae	Shrub
41	*Anthonotha macrophylla*	ANMA	Cesalipinioideae	Shrub
42	*Anthephora ampilliaceae*	ANAM	Poaceae	Shrub
43	*Antiaris Africana*	ANAF	Moraceae	Tree
44	*Antiaris toxicaria*	ANTO	Moraceae	Tree
45	*Asparagus flagellaris*	ASFL	Caesalpinioideae	Tree
46	*Aspillia Africana*	ASAF	Asteraceae	Herb
47	*Aspillia busei*	ASBU	Asteraceae	Herb
48	*Asystatsia gangetica*	ASGA	Acanthaceae	Shrub
49	*Azadirachta indica*	AZIN	Azadirachtaceae	Tree
50	*Axonopus compressus*	AXCO	Poaceae	Grass
51	*Bambussa vulgaris*	BAVU	Poaceae	Grass
52	*Bidens pilosa*	BIPI	Asteraceae	Herb
53	*Blepharis maderoapatensis*	BLMA	Acanthaceae	Shrub
54	*Blighia sapida*	BLSA	Sapindaceae	Tree
55	*Blighia welwetehii*	BLWE	Sapindaceae	Tree
56	*Boerharia coccinea*	BODI	Nyctagmaceae	Tree
57	*Boerharia deflexa*	BOCO	Nyctagmaceae	Tree
58	*Bombax buanopozense*	BOBU	Bombacaceae	Tree
59	*Brachiera deflexa*	BRDE	Poaceae	Grass
60	*Brachystegia eurycoma*	BREU	Caesalpinioideae	Tree
61	*Bridelia feruginea*	BRFE	Euphorbiaceae	Tree
62	*Bridelia micrantha*	BRMI	Euphorbiaceae	Tree

63	*Burkea Africana*	BUAF	Caesalpinioideae	Tree
64	*Cajanus cajan*	CACA	Poaceae	Shrub
65	*Calotropis procera*	CAPR	Bombacaceae	Shrub
66	*Canavalium ensiformis*	CAEN	Papillionaceae	Climber
67	*Canhium vulgera*	CAVU	Rabiaceae	Grass
68	*Carica papaya*	CAPA	Caricaceae	Pseudo tree
69	*Carpolobea lutea*	CALU	Polygalaceae	Shrub/Herb
70	*Cassia alata*	CAAL	Caesalpinioideae	Tree
71	*Cassia monosoides*	CAMI	Caesalpinioideae	Tree
72	*Cassia podocarpa*	CAPO	Caesalpinioideae	Tree
73	*Cassia siamea*	CASI	Caesalpinioideae	Tree
74	*Ceiba pentadra*	CEPE	Bombacaceae	Tree
75	*Celosia argentea*	CEAR	Amaranthaceae	Herb
76	*Celtis zenkeri*	CEZE	Ulmaceae	Tree
77	*Centrocema puebescens*	CEPU	Papillionaceae	Climber
78	*Chamaecrista mimosoides*	CHMI	Poaceae	Grass
79	*Chloris pilosa*	CHPO	Poaceae	Grass
80	*Chassalia kolly*	CHKO	Poaceae	Grass
81	*Chrosopogon aciculatus*	CHAC	Poaceae	Grass
82	*Cissampelos mucronanta*	CIMU	Menispermaceae	Herb
83	*Chromalaena odoratum*	CHOD	Asteraceae	Herb
84	*Chrysophyllum albidum*	CHAL	Sapotaceae	Tree
85	*Citrus sinensis*	CISI	Rutaceae	Tree
86	*Clappertoniana ficifolia*	CLFI	Tiliaceae	Shrub
87	*Cleistopholis paten*	CLPA	Annonaceae	Tree
88	*Cleoma viscose*	CLVI	Cleomaceae	Shrub
89	*Cnestis feruginea*	CNFE	Connaraceae	Shrub
90	*Cocos nucifera*	CONU	Palmae	Tree
91	*Cochlospermum planchonii*	COPL	Cochlospaermaceae	Shrub
92	*Coffea brevipas*	COBR	Rubiaceae	Tree
93	*Cola afzelii*	COAF	Sterculiaceae	Tree
94	*Cola gigantean*	COGI	Sterculiaceae	Tree
95	*Cola milleni*	COMI	Sterculiaceae	Tree

96	*Cola nitida*	CONI	Sterculiaceae	Tree
97	*Combretum bracteaunm*	COBC	Combretaceae	Tree
98	*Combretum hispidum*	COHI	Combretaceae	Tree
99	*Combretum racemosum*	CORA	Combretaceae	Tree
100	*Combretum molle*	COMO	Combretaceae	Tree
101	*Combretum zenkeri*	COZE	Combretaceae	Tree
102	*Commelina benghalensis*	COBE	Commelinaceae	Tree
103	*Commelina nodiflora*	CONO	Commelinaceae	Tree
104	*Conyza sumatrensis*	COSU	Asteraceae	Herb
105	*Corchorus olitorius*	COOL	Tiliaceae	Herb
106	*Croton lobatus*	CRLO	Euphorbiaceae	Herb
107	*Crotolaria retusa*	CRRE	Papillionaceae	Shrub
108	*Crassocephalum rubens*	CRRU	Papillionaceae	Grass
109	*Crescentia*	CRCU	Cucurbitaceae	Shrub/Tree
110	*Cucurbita pepo*	CUPE	Cucurbitaceae	Climber
111	*Cucumeropsis manni*	CUMA	Cucurbitaceae	Climber
112	*Cussonia barteri*	CUBA	Araliaceae	Tree
113	*Cyanolis lanata*	CYLA	Amaranthaceae	Herb
114	*Cymbopogon giganteus*	CYGI	Poaceae	Grass
115	*Cyathula prostrata*	CYPR	Poaceae	Grass
116	*Cynodon dactylon*	CYDA	Poaceae	Grass
117	*Cynometra megalophylla*	CYME	Caesalpinioideae	Herb
118	*Cyperus articulatus*	CYAR	Cyperaceae	Sedges
119	*Cyperus esculentus*	CYES	Cyperaceae	Sedges
120	*Cyperus iria*	CYIR	Cyperaceae	Sedges
121	*Dactyloctenium aegyptium*	DAAE	Poaceae	Grass
122	*Daniella olliverii*	DAOL	Caesalpinioideae	Tree
123	*Deloni regia*	DERE	Caesalpinioideae	Tree
124	*Deinbollia pinnata*	DEPI	Sapindaceae	Tree
125	*Desmodium salcifolium*	DESA	Papillionaceae	Herb
126	*Detarium macrocarpum*	DEMA	Caesalpinioideae	Tree
127	*Dialium guinensis*	DIGU	Caesalpinioideae	Tree
128	*Discorea prahensilis*	DIPR	Dioscoreaceae	Climber

129	*Dioseorea alata*	DIAL	Dioscoreaceae	Climber
130	*Discorea cayenensis*	DICA	Dioscoreaceae	Climber
131	*Diospyros mesipiliformis*	DIME	Ebenaceae	Tree
132	*Diospyros monbutensis*	DIMO	Ebenaceae	Tree
133	*Dichrostachys cinerea*	DICI	Mimosoideae	Tree
134	*Diplazium sammatii*	DISA	Athyriaceae	Tree
135	*Distemonanthus benthamanus*	DIBE	Caesalpinioideae	Tree
136	*Dracaena fragranus*	DRFR	Agavaceae	Shrub
137	*Eclipia alba*	ECAL	Asteraceae	Shrub
138	*Elaeisi guinensis*	ELGU	Palmae	Pseudo tree
139	*Eleusine indica*	ELIN	Poaceae	Grass
140	*Entanda Africana*	ENAF	Mimosoideae	Herb
141	*Eragrostis tremula*	ERTR	Poaceae	Grass
142	*Erythrina senegalensis*	ERSE	Caesalpinioideae	Shrub/Tree
143	*Erythrophleum suaveolensis*	ERSU	Caesalpinioideae	Tree
144	*Euphorbia hirta*	EUHI	Euphorbiaceae	Herb
145	*Euphorbia lateriflora*	EULA	Euphorbiaceae	Herb
146	*Ficus capensis*	FICA	Moraceae	Tree
147	*Ficus exasperata*	FIEX	Moraceae	Tree
148	*Ficus mucoso*	FIMU	Moraceae	Tree
149	*Ficus thioningii*	FITH	Moraceae	Tree
150	*Ficus sycomorus*	FISY	Moraceae	Tree
151	*Funtumia elastic*	FUEL	Apocynaceae	Tree
152	*Gardenia trenifolia*	GATE	Rubiaceae	Shrub/tree
153	*Gardenia aqaulla*	GAAQ	Rubiaceae	Shrub/Tree
154	*Gliricidia sepium*	GLSE	Papillionaceae	Shrub/Tree
155	*Glyphaea brevipes*	GLBR	Tiliaceae	Shrub/Tree
156	*Gmelina arboreus*	GMAR	Verbenaceae	Tree
157	*Gossypium barbadense*	GOBA	Bombacaceae	Tree
158	*Grevia carpinifolia*	GRCA	Tiliaceae	Tree
159	*Grevia flavescens*	GRFL	Tiliaceae	Tree
160	*Greivia mollis*	GRMO	Tiliaceae	Tree
161	*Guarea cedrata*	GUCE	Meliaceae	Tree

162	*Harrisonia abyssinica*	HAAB	Simaroubaceae	Tree
163	*Hedranthera barteri*	HEBA	Simaroubaceae	Tree
164	*Heinsia crinita*	HECR	Rubiaceae	Tree
165	*Hewittia sublobata*	HESU	Convolvulaceae	Herb
166	*Hibiscus asper*	HIAS	Malvaceae	Shrub
167	*HIBIscus sabdarrifa*	HISA	Malvaceae	Shrub
168	*Hibiscus rostellatus*	HIRO	Poaceae	Grass
169	*Hiprocratea patten*	HIPA	Poaceae	Grass
170	*Hollarhena floribunda*	HOFL	Aprigmaceae	Tree
171	*Holoptelia grandis*	HOGR	Ulmaceae	Tree
172	*Homalium letestui*	HOLE	Samydaceae	Tree
173	*Hyparhenia involucrate*	HYIN	Poaceae	Grass
174	*Hyparhenia rufa*	HYRU	Poaceae	Grass
175	*Hmneocardia acida*	HYAC	Euphorbiaceae	Tree
176	*Icacinia tricantha*	ICTR	Icacimaceae	Shrub/Herb
177	*Imperata cylindrical*	IMCY	Poaceae	Grass
178	*Indigofera capitata*	INCA	Papillionaceae	Herb
179	*Irvingia gabonensis*	IRGA	Ixonamthaceae	Tree
180	*Irvingia wombolu*	IRWO	Ixonamthaceae	Tree
181	*Ipomea asarifolia*	IPAS	Convolvulaceae	climber/Crawler
182	*Jatropha carcass*	JACU	Euphorbiaceae	Shrub
183	*Justicia flava*	JUFL	Acanthaceae	Climber
184	*Khaya ivorensis*	KHIV	Meliaceae	Tree
185	*Kigelia africana*	KIAF	Bignoniaceae	Tree
186	*Lannea nigritana*	LANI	Anarcardiaceae	Tree
187	*Lannea welwetehii*	LAWE	Anarcardiaceae	Tree
188	*Lannea taraxacifolia*	LATA	Asteraceae	Tree
189	*Lagenaria siceranía*	LASI		Tree
190	*Laportea aestanus*	LAAE	Urticaceae	
191	*Leersia hexandra*	LAHE	Poaceae	Grass
192	*Lactuca capensis*	LACP	Asteraceae	Shrub
193	*Lantana camara*	LACA	Verbenaceae	Shrub/Herb
194	*Lecaniodiscus cupanioides*	LECU	Sapindaceae	Tree

195	*Lonchocarpus cyanescens*	LOCY	Papillionaceae	Shrub/Herb
196	*Lonchocarpus griffonianus*	LOGR	Papillionaceae	Shrub/Herb
197	*Lophira lanceolata*	LOLA	Ochnaceae	Tree
198	*Lovoa trichiloides*	LOTR	Meliaceae	Tree
199	*Ludiwigia deeuirens*	LUDE	Onagreceae	Tree
200	*Macaranga barterii*	MABA	Euphorbiaceae	Tree
201	*Machrosphyra longistyla*	MALO	Rubiaceae	Tree
202	*Malotus oppositifolius*	MAOP	Euphorbiaceae	Tree
203	*Malancantha alnifolia*	MAAL	Sapotaceae	Tree
204	*Magnifera indica*	MAIN	Anarcardiaceae	Tree
205	*Malvastrum corimandelianum*	MACO	Malvaceae	Tree
206	*Manihot esculenta*	MAES	Euphorbiaceae	Shrub/herb
207	*Maniophyton fulvum*	MAFU	Euphorbiaceae	Shrub/herb
208	*Maytenus senegalensis*	MASE	Celastraceae	Tree
209	*Magariteria discoideae*	MADI	Euphorbiaceae	Tree
210	*Microdesmis puberula*	MIPU	Euphorbiaceae	Tree
211	*Milicia excels*	MIEX	Moraceae	Tree
212	*Mimosa pudica*	MIPD	Mimosoideae	Herb
213	*Manscus alternifolius*	MAAF	Cyperaceae	Sedges
214	*Manscus flabelloformis*	MAFL	Cyperaceae	Sedges
215	*Mitragyna inermis*	MIIN	Moraceae	Shrub/Tree
216	*Melanthra scandens*	MESC	Asteraceae	Shrub
217	*Momordica charantai*	MOCH	Cucurbitaceae	Climber
218	*Mimosa invisa*	MIIV	Mimosoideae	Herb
219	*Morinda lucida*	MOLU	Rubiaceae	Shrub/Tree
220	*Monodorna tennifolia*	MOTE	Annonaceae	Tree
221	*Moringa oleifera*	MOOL	Moringaceae	Shrub/Tree
222	*Mucuna prurens*	MUPR	Papillionaceae	Climber
223	*Mucuna sloanei*	MUSL	Papillionaceae	Climber
224	*Musa sapientum*	MUSA	Musaceae	Pseudo tree
225	*Musa paradisiacal*	MUPA	Musaceae	Pseudo tree
226	*Myrianthus arboreus*	MYAR	Moraceae	Shrub/Tree
227	*Nauchlea latifolia*	NALA	Rubiaceae	Tree

228	*Newbouldia laevis*	NELA	Bignoniaceae	Tree
229	*Ocimum grattasimum*	OCGR	Lamiaaceae	Shrub/Tree
230	*Oryza longistanimata*	ORLO	Poaceae	Sedges
231	*Ocimum canum*	OCCA	Lamiaaceae	Shrub/Tree
232	*Olax subarolata*	OLSB	Olacaaceae	Tree
233	*Olax subscorpoidea*	OLSU	Olacaaceae	Tree
234	*Opillia celtidifolia*	OPCE	Opilliaaceae	Herb
235	*Panicum maximum*	PAMA	Poaceae	Grass
236	*Panicum laxum*	PALA	Poaceae	Grass
237	*Parinari robusta*	PARO	Rosaaceae	Tree
238	*Parinari polyandra*	PAPO	Rosaaceae	Tree
239	*Parkia becolor*	PABI	Mimosoideae	Tree
240	*Parkia biglobosa*	PABG	Mimosoideae	Tree
241	*Parinari glabra*	PAGL	Rosaaceae	Tree
242	*Parquettina nigreseen*	PANI	Periplocaaceae	Tree
243	*Palisota hirsute*	PAHI	Commelinaceae	Herb
244	*Paspalum norranthus*	PANO	Poaceae	Grass
245	*Pennisetum pedicellatum*	PEPE	Poaceae	Grass
246	*Pennisetum purpureum*	PEPU	Poaceae	Grass
247	*Phyllanthus discoides*	PHDI	Euphorbiaceae	Herb
248	*Pilostigma thoningii*	PITH	Caesalpinioideae	Shrub/tree
249	*Poulilzozia giunensis*	POGU	Poaceae	Grass
250	*Paullinia pinnata*	PAPI	Sapindaceae	Tree
251	*Physalis micrantha*	PHMI	Euphorbiaceae	Tree
252	*Prosopis Africana*	PRAF	Mimosoideae	Tree
253	*Psorospermum febrifugum*	PSFE	Hypericaaceae	Shrub
254	*Paspalum conjugatum*	PACO	Poaceae	Grass
255	*Pterocarpus santalinoides*	PTSA	Papillionaceae	Tree
256	*Pupalia lappacea*	PULA	Amaranthaceae	Herb
257	*Psidium guajava*	PSGU	Myrtaceae	Tree
258	*Peperomia pellucid*	PEPL	Piperraceae	Tree
259	*Pterocarpus erinaceus*	PTER	Papillionaceae	Tree
260	*Pterocarpus mildbraedii*	PTMI	Papillionaceae	Tree

261	*Pennisetum violacea*	PEVI	Poaceae	Grass
262	*Raphia hookerii*	RAHO	Palmae	Pseudo tree
263	*Reissantia indica*	RAIN	Hyppocrateaceae	Grass
264	*Rhynchospora corymbosa*	RHCO	Cyperaceae	Sedges
265	*Rauvolvisa vomitoria*	RAVO	Apocynaceae	Tree
266	*Ricinodendron heudelotii*	RIHE	Euphorbiaceae	Herb
267	*Ricinus communis*	RICO	Euphorbiaceae	Climber
268	*Rinoria dentrata*	RIDE	Volaceae	Tree
269	*Rothmania longiflora*	ROLO	Rubiaceae	Tree
270	*Sansevierasenegambica*	SASE	Agaraceae	Grass
271	*Sanseviera liberica*	SALI	Agaraceae	Grass
272	*Securidaca longipendiculata*	SELO	Polygalaceae	Tree
273	*Schramkia leptocarpa*	SCLE	Mimosoideae	Tree
274	*Securinega virosa*	SEVI	Euphorbiaceae	Shrub
275	*Scleria verrucosa*	SCVE	Cyperaceae	Herb
276	*Sesamium indicum*	SEIN	Pedoliaceae	Herb
277	*Senna hirsute*	SEHI	Caesalpinioideae	Herb
278	*Sida acuta*	SIAC	Malvaceae	Herb
279	*Sida corymbosa*	SICO	Malvaceae	Herb
280	*Smilax krausiana*	SMKR	Smilacaceae	Herb
281	*Solanum aethiopicum*	SOAE	Solanaceae	Herb
282	*Seteria megaphylla*	SEME	Poaceae	Herb
283	*Solanum americanum*	SOAM	Solanaceae	Herb
284	*Solanum dasyphyllum*	SODA	Solanaceae	Herb
285	*Solenostemon monostachyus*	SOMO	Lamiaaceae	Herb
286	*Solanum erianthum*	SOER	Solanaceae	Herb
287	*Solanum macrocarpum*	SOMA	Solanaceae	Herb
288	*Spathoidea campanulata*	SPCA	Bignoniaceae	Tree
289	*Spondias mombim*	SPMO	Anarcardiaceae	Tree
290	*Sphenocentrum jollyanum*	SPJO	Menispermaceae	Shrub
291	*Sterculia tragacantha*	STTR	Sterculiaceae	Tree
292	*Struchium sparganophora*	STSP	Asteraceae	Herb
293	*Syndrella nodiflora*	SYNO	Asteraceae	Herb

294	*Tamarindus indica*	TAIN	Mimosoideae	Tree
295	*Talinum triangulare*	TATR	Portulacaceae	Herb
296	*Tectona grandis*	TEGR	Verbenaceae	Herb
297	*Tephrosia braceolata*	TEBR	Papillionaceae	Shrub
298	*Tephrosia pedicellata*	TEPE	Papillionaceae	Shrub
299	*Terminalia glaucesceus*	TEGL	Combretaceae	Tree
300	*Terminalia superb*	TESU	Combretaceae	Tree
301	*Theobroma cacao*	TACA	Sterculiaceae	Tree
302	*Tithonia divesifolia*	TIDI	Asteraceae	Herb
303	*Trema orientalis*	TRDR	Ulmaceae	Herb
304	*Tridax procumbens*	TRPR	Asteraceae	Herb
305	*Triplochiton sclerotylon*	TRSC	Sterculiaceae	Tree
306	*Trumtet cordifolia*	TRCO	Tiliaceae	Shrub
307	*Uvaria chamae*	UVCH	Cucurbitaceae	Climber
308	*Urenia lobata*	URLO	Malvaceae	
309	*Vernonia amygdalina*	VEAM	Asteraceae	Shrub
310	*Vernonia ambigua*	VEAB	Asteraceae	Shrub
311	*Vernonia anercii*	VEAN	Asteraceae	Shrub
312	*Vernonia perrottetii*	VEPE	Asteraceae	Shrub
313	*Vitex doniana*	VIDO	Verbenaceae	Tree
314	*Waltheria indica*	WAIN	Sterculiaceae	Shrub
315	*Xylopia quintasii*	XYDU	Annonaceae	Shrub/Tree
316	*Zanthoxylum zanthoxyloides*	ZAZA	Rutaceae	Shrub/Tree
317	*Vitellaria paradoxa*	VIPA	Sapotaceae	Tree

APPENDIX 3

NAMES, CODE AND TAXONOMIC CHARACTERISTICS OF ANIMAL IN THE STUDY AREA

COUPLET NO.	SCIENTIFIC NAME	ENGLISH NAME	CODE	CLASS	FAMILY
1	*Actophilornis africana*	Lily rotter	ACAF	Birds	Jacanidae
2	*Agama agama*	Agama lizard	AGAG	Reptiles	Agamidae
3	*Ardea cinera*	Grey heron	ARCI	Birds	Ardeidae
4	*Arvicanthus niloticus*	Nile rat	ARNI	Mamamal	Rattus
5	*Artheris chloraechis*	Brown snake	ARCH	Reptiles	Colubridae
6	*Anthus leucophrys*	Plainbacked pipit	ANLE	Birds	Motacillidae
7	*Bitis gabonica*	Gabon viper	BIGA	Reptiles	Viperridae
8	*Bostrichia hagedash*	Hadada ibis	BOHA	Birds	Threskionithidae
9	*Bothropthalmus ,ineatum*	Sidestripe brown snake	BOLI	Reptiles	Colubridae
10	*Bulbulcus ibis*	Cattle egret	BUIB	Birds	Ardeidae
11	*Burhinus senegalensis*	Senegal thick snale	BUSE	Birds	Burhinidae
12	*Carprimulgus spp*	Night jar	CASP	Birds	Caprimulgidae
13	*Centropus grilli*	Black coucal	CEGR	Birds	Cuculidae
14	*Centropus senegalensis*	Senegal coucal	CESE	Birds	Cuculidae
15	*Cephalophus maxwellii*	Maxwell duiker	CEMA	Mamamal	Cephalophinae
16	*Cephalophus rufilatus*	Red flanked duiker	CERU	Mamamal	Cephalophinae
17	*Cephalophus spp*	Duiker	CESP	Mamamal	Cephalophinae
18	*Cercopitheecus mona*	Mona monkey	CEMO	Mamamal	Cercopithecidae
19	*Ceryle rudis*	Pied king fisher	CERU	Birds	Alcedinidae
20	*Ciconia abdmii*	Abdim stork	CIAb	Birds	Ciconidae
21	*Cisticola cantan*	Lanceolated warbier	CICA	Birds	Sylvidae
22	*Cisticola galactotes*	Grass wabler	CIGA	Birds	Sylvidae
23	*C,amator glandarius*	Great spottted cukoo	CLGA	Birds	Campephagidae
24	*Clamator jacobinus*	Jaccobin cukoo	CLJA	Birds	Campephagidae
25	*Clamator levallanti*	Levaillant african cukoo	CLLE	Birds	Campephagidae
26	*Coracias abysinica*	Abysinia roller	COAB	Mamamal	Coraciidae
27	*Coracias cyanogaster*	Bleud bellied roller	COCY	Mamamal	Coraciidae
28	*Corvinella corvine*	Long tail shrike	COCO	Mamamal	Lanildae
29	*Corvus albus*	Pied cow	COAL	Mamamal	Corvidae
30	*Corythaeola cristata*	Blue plantain eater	COCR	Mamamal	Musophagidae
31	*Cricetomys gamianus*	Giant rat	CRGA	Mamamal	Cricetidae
32	*Crinifer piscator*	Grey plantain eater	CRPI	Birds	Musophagidae

33	*Cypsiuurus parvus*	African palm swift	CYPA	Birds	Apodidae
34	*Dendroaspis virindis*	Green mamba	DEVI	Reptiles	Elapidae
35	*Dendrocygna viduata*	White faced tree duck	DEVD	Birds	Anatidae
36	*Dendrohyrax dorsalis*	Tree hyrax	DEDO	Mamamal	Provaviidae
37	*Dendropicos fuscescens*	Cardinal woodpecker	DEFU	Birds	Picidae
38	*Epixerus ebii*	Red headed tree squirrel	EPEB	Mamamal	Sciuridae
39	*Erythrocebus patas*	Patas monkey	ERPA	Mamamal	Cercopithecidae
40	*Estrilda melpoda*	Orange cheeked waxbill	ESME	Birds	Estrildae
41	*Euplectes orix*	Red bishop	EUOR	Birds	Estrildae
42	*Euplectes macrourus*	Yellow mantle whydah	EUMA	Birds	Ploceidae
43	*Francolinus bicalcaratus*	Francolin (Bush fow)	FRBI	Birds	Phasiannidae
44	*Fraseria ocreata*	Fraser forest flycatcher	FROC	Birds	Mucicapidae
45	*Genetta macullatta*	Forest genet (Maloko)	GEMA	Mamamal	Viverridae
46	*Genetta trigrina*	Serval cat (Ogbo)	GETR	Mamamal	Viverridae
47	*Gypohierax angolensis*	Plamnut vulture	GYAN	Birds	Accipitiridae
48	*Halcyon leucocephala*	Grey headed kingfisher	HALE	Birds	Alcedinidae
49	*Halcyon malimbica*	Blue breasted kingfisher	HAMA	Birds	Alcedinidae
50	*Hacyon senegalensis*	Sengal kingfisher	HASE	Birds	Alcedinidae
51	*Haliatus vocifer*	Fish (River) Eagle	HAVO	Birds	Accipitiridae
52	*Heliosciurus puncatus*	Small forest swallow	HEPU	Birds	Sciuridae
53	*Hirundo semirufa*	Rufuos chested swallow	HISE	Birds	Hirundidae
54	*Hirundo senegalensis*	Mospue swallow	HISG	Birds	Hirundidae
55	*Hylochoerus minertzhageni*	Bush pig	HYMI	Mamamal	Suidae
56	*Hystrix cristata*	Crested porcupine	HYCR	Mamamal	Hysricidae
57	*Indicator indicator*	Greater honey guide	ININ	Birds	Indicatoridae
58	*Indicator minor*	Lesser honey guide	INMI	Birds	Indicatoridae
59	*Kaupifalco monogrammiscus*	Lizard Buzzard	KAMO	Birds	Accipitiridae
60	*Logonosticta senegala*	Senegal fire finch	LASE	Birds	Fringilidae
61	*Lamptotornis spp*	Glossy starlings	LASP	Birds	Sturnidae
62	*Laniarus artoflavus*	Yellow billed shrike	LAAR	Birds	Lanildae
63	*Lemniscormys striatus*	Spotted grass mouse	LEST	Mamamal	Rattus
64	*Lepus capensis*	Hare	LECA	Mamamal	Leporidae
65	*Lonhura bicolor*	Black and white manikin	LOBI	Birds	Estrildae
66	*Lonchura cucullata*	Bronse manikin	LOCU	Birds	Estrildae
67	*Lophuromys sikapusi*	Rufuos bellied rat	LOSI	Mamamal	Rattus
68	*Lybius veilliot*	veilliot barbet	LYNE	Birds	Capitornidae
69	*Macronyx crocent*	Yellow throated long claw	MACR	Birds	Motacillidae
70	*Merops albicolis*	White throated bee eater	MEAL	Birds	Meropidae
71	*Merops malimbicus*	Rosy bee eater	MEMA	Birds	Meropidae
72	*Merops muellenii*	Black headed bee eater	MEMU	Birds	Meropidae

73	*Merops nubicus*	Carmine bee eater	MENU	Birds	Apodidae
74	*Micropus caffer*	White rumped swift	MICA	Birds	Apodidae
75	*Milvus migrans*	Black kite	MIMI	Birds	Accipitiridae
76	*Motacilla flava*	Yellow wagtail	MOFL	Birds	Motacillidae
77	*Mungos obsciurus*	Long nose mongoose	MUOB	Mamamal	Viverridae
78	*Mus minutoides*	Pigmy mouse	MUMI	Mamamal	Rattus
79	*Musophaga violacea*	Violet plantain eater	MUVI	Birds	Musophagidae
80	*Naja melanoleuca*	Black cobra	NAME	Reptiles	Elapidae
81	*Numida meleagris*	Giunea fowl	NUME	Birds	Phasiannidae
82	*phoeniculus atterimus*	Lesser (Green) wood hoope	PHAT	Birds	Upupidae
83	*Phylloscopus trochillus*	Wilow warbler	PHTR	Birds	Sylvidae
84	*Ploceus cucullatus*	Village weaver bird	PLCU	Birds	Ploceidae
85	*Ploceus melanocephalus*	Black headed weaver	PLME	Birds	Ploceidae
86	*Pogonileus subsulpheus*	Yellow rumped tinker bird	POSU	Birds	Pogonidae
87	*Poicephalus senegalus*	Senegal parrot	POSE	Birds	Psittacidae
88	*Polyboroides radiates*	Harrier hawk	PORA	Birds	Accipitiridae
89	*Procavia ruficeps*	Rock hyrax	PRRU	Mamamal	Procaviidae
90	*Protexerus aubinni*	Slender tailed squirrel	PRAU	Mamamal	Sciuridae
91	*Protexerus strangerii*	Gaint forest squirel	PRST	Mamamal	Sciuridae
92	*Psamophis sibilans*	Yellow stripe snake	PSSI	Reptiles	Colubridae
93	*Psamophis sibilans philipsii*	Yellow snake	PSSP	Reptiles	Colubridae
94	*Pyconotus barbatus*	Common garden bulbul	PYBA	Birds	Pyconotidae
95	*Python sebae*	Rock python	PYSE	Reptiles	Boidae
96	*Rattus natalensis*	Muiltimammate rat	RANA	Mamamal	Rattus
97	*Rousethus smithii*	Fruit bat	ROSM	Mamamal	Chiroptera
98	*Schoenicola platyura*	Fan tailed swamp barbler	SCPL	Birds	Timalidae
99	*Scopus umbretta*	Hammerkop	SCUM	Birds	Scopidae
100	*Sphenoeacus mentalis*	Moustached grass warbler	SPME	Birds	Sylvidae
101	*Streptopelia decipens*	African (morning) dove	STDE	Birds	Colubridae
102	*Streptopelia senegalensis*	Laughing dove	STSE	Birds	Colubridae
103	*Streptopelia semitorquata*	Red Eyed dove	STSQ	Birds	Colubridae
104	*Streptopelia turtur*	European turtle dove	STTU	Birds	Colubridae
105	*Streptopelia vinacea*	Veinaceous dove	STVI	Birds	Colubridae
106	*ateri kempi*	Kemps gerbil	TAKE	Mamamal	Rattus
107	*Thryonomys swinderianus*	Grasscutter	THSW	Mamamal	Thryonomidae
108	*Tockus erthorhyncus*	African hornbill	TOER	Birds	Bucerotidae
109	*Tockus nasutus*	Afrcan grey hornbill	TONA	Birds	Bucerotidae
110	*Tragelaphus scriptus*	Bush buck	TRSCm	Mamamal	Tragelaphidae
111	*Teron australis*	Green pigeon fruit	TRAU	Birds	Colubridae
112	*Turdoides reinwardii*	Black cap barbler	TURE	Birds	Timalidae

113	*Turdus Pelios*	West African thrush	TUPE	Birds	Turbidae
114	*Tyto alba*	Owl	TYAL	Birds	Strigidae
115	*Veranus examthematicus*	Short tailed Nile monitor	VEEX	Reptiles	Veramidae
116	*Veranus niloticus*	Monitor lizard	VENI	Reptiles	Veramidae
117	*Viverra civetta*	Civet cat	VICI	Mamamal	Viverridae
118	*Vidua macroura*	Pin tailed whydah	VIMA	Birds	Ploceidae
119	*Xerus erythropus*	White stripe ground squirel	XEER	Mamamal	Sciuridae
120	*Xerus sp*	Plain body ground squirel	XESP	Mamamal	Sciuridae
121	*Zosterops senegalensis*	Yellow white eye	ZOSE	Mamamal	Zosterpidae

APPENDIX 4

ABUNDANCE AND RELATIVE ABUNDANCE VALUE OF ANIMAL ENCOUNTERED IN THE STUDY AREA

S/N	Code	Total No. of Animal	Abundance	Rela. Abd.
1	ACAF	17	0.08	0.044 ± 1.133
2	AGAG	26	0.12	0.068 ± 1.252
3	ANLE	266	1.24	0.692 ± 13.925
4	ARCI	6	0.03	0.016 ± 0.400
5	ARNI	1444	6.75	3.760 ± 15.387
6	ATCH	7	0.03	0.018 ± 0.322
7	BIGA	5	0.02	0.014 ± 0.322
8	BOHA	2	0.01	0.006 ± 0.160
9	BOLI	13	0.05	0.034 ±0.571
10	BUIB	1399	6.54	3.644 ± 49.183
11	BUSE	9	0.04	0.024 ±0.314
12	CASP	72	0.34	0.188 ± 2.288
13	CEGR	20	0.1	0.052 ± 0.638
14	CESE	134	0.64	0.350 ± 5.632
15	CEMA	49	0.22	0.128 ± 0.803
16	CERU	6	0.03	0.016 ± 0.400
17	CESP	169	0.79	0.440 ± 1.579
18	CEMO	46	0.22	0.120 ± 2.519
19	CERD	22	0.1	0.058 ± 0.753
20	CIAB	10	0.05	0.026 ± 0.753
21	CICA	7	0.03	0.018 ± 0.381
22	CIGA	57	0.27	0.148 ± 2.593
23	CLGL	14	0.07	0.036 ± 0.798
24	CLJA	42	0.2	0.110 ± 1.945
25	CLLE	34	0.16	0.088 ± 1.743
26	COAB	29	0.14	0.076 ± 1.181
27	COCY	11	0.05	0.028 ± 0.463
28	COCO	8	0.03	0.020 ± 0.463
29	COAL	413	1.93	1.076 ± 7.640
30	COCR	25	0.12	0.066 ± 1.609
31	CRGA	136	0.64	0.354 ± 0.900
32	CRPI	17	0.08	0.044 ± 0.820
33	CYPA	58	0.27	0.152 ± 2.327
34	DEVI	25	0.12	0.066 ± 0.671
35	DEVD	40	0.19	0.104 ± 3.192
36	DEDO	19	0.1	0.050 ± 1.102
37	DEFU	42	0.2	0.110 ± 1.782
38	EPEB	142	0.66	0.37 ± 2.976

39	ERPA	91	0.43	0.238 ± 3.716
40	ESME	7	0.03	0.018 ± 0.399
41	EUOR	0	0	0.000 ± 0.000
42	EUMA	23	0.11	0.060 ± 1.669
43	FRBI	1095	5.12	2.852 ± 12.229
44	FROC	6	0.03	0.016 ± 0.276
45	GEMA	0	0	0.000 ± 0.000
46	GETR	1	0	0.002 ± 0.079
47	GYAN	4	0.01	0.010 ± 0.320
48	HALE	0	0	0.000 ± 0.000
49	HAMA	1	0	0.002 ± 0.079
50	HASE	4	0.01	0.010 ± 0.320
51	HAVO	3	0.01	0.008 ± 0.171
52	HEPU	17	0.08	0.044 ± 0.571
53	HISE	10	0.05	0.026 ± 0.798
54	HISG	24	0.11	0.062 ± 1.225
55	HYMI	77	0.36	0.200 ± 3.589
56	HYCR	37	0.17	0.096 ± 1.175
57	ININ	11	0.05	0.028 ± 0.795
58	INMI	192	0.9	0.500 ± 8.308
59	KAMO	96	0.45	0.250 ± 1.965
60	LASE	13	0.06	0.034 ± 0.953
61	LAAR	9	0.04	0.024 ± 0.393
62	LASP	38	0.18	0.098 ± 2.421
63	LEST	60	0.28	0.156 ± 0.896
64	LECA	457	2.14	1.190 ± 5.865
65	LOBI	51	0.24	0.132 ± 0.739
66	LOCU	2278	10.66	5.932 ± 27.500
67	LOSI	50	0.23	0.052 ± 1.853
68	LYVE	15	0.07	0.040 ± 0.809
69	MACR	7	0.03	0.018 ± 0.299
70	MEAL	11	0.05	0.028 ± 0721
71	MENU	21	0.1	0.054 ± 1.143
72	MEMA	251	1.22	0.680 ± 8.416
73	MEMU	17	0.08	0.044 ± 0.975
74	MICA	0	0	0.000 ± 0.000
75	MIMI	133	0.62	0.346 ± 4.360
76	MOFL	132	0.62	0.344 ± 7.101
77	MUOB	12	0.06	0.032 ±0.717
78	MUMI	7	0.03	0.018 ± 0.416
79	MUVI	77	0.36	0.200 ± 0.731
80	NAME	10	0.05	0.026 ± 0.388
81	NUME	658	3.08	1.714 ± 12.214
82	PHAT	22	0.1	0.058 ± 0.772

83	PHTR	177	0.83	0.462 ± 7.520
84	PLCU	1588	7.43	4.136 ±3.904\
85	PLME	230	1.08	0.600 ± 10.152
86	POSU	20	0.1	0.052 ± 1.070
87	POSE	2	0.01	0.006 ± 0.160
88	PORA	4	0.02	0.010 ± 0.320
89	PRRU	19	0.09	0.050 ±0.931
90	PRAU	17	0.08	0.044 ± 0.854
91	PRST	30	0.14	0.078 ±0.870
92	PSSI	7	0.03	0.018 ± 0.478
93	PSSP	48	0.22	0.126 ± 1.893
94	PYBA	7	0.03	0.018 ± 0.322
95	PYSE	0	0	0.000 ± 0.000
96	RANA	16	0.08	0.042 ± 0.785
97	ROSM	759	3.55	1.976 ± 57.632
98	SCPL	31	0.14	0.080 ± 2.219
99	SCUM	3	0.01	0.008 ± 0.239
100	SPME	163	0.76	0.424 ± 8.812
101	STDE	9	0.04	0.024 ±0.266
102	STSE	90	0.42	0.234 ± 5.502
103	STSQ	52	0.24	0.136 ± 1.327
104	STTU	158	0.74	0.412 ± 4.823
105	STVI	20	0.1	0.052 ± 0.802
106	TAKE	12	0.05	0.032 ± 0.289
107	THSW	5342	25	13.912 ± 40.871
108	TOER	26	0.12	0.068 ± 0.686
109	TONA	69	0.32	0.180 ± 1.292
110	TRSC	176	0.82	0.458 ± 1.082
111	TRAU	596	2.79	1.552 ± 17.995
112	TUPE	25	0.12	0.066 ± 1.244
113	TURE	10	0.05	0.026 ± 0.715
114	TYAL	1	0	0.002 ± 0.079
115	VEEX	3	0.01	0.008 ± 0.171
116	VENI	9	0.04	0.024 ± 0.443
117	VIMA	32	0.15	0.084 ± 1.502
118	VICI	136	0.64	0.354 ± 5.452
119	XEER	488	2.28	1.270 ± 2.976
120	XESP	117	0.55	0.304 ± 6.240
121	ZOSE	6	0.03	0.016 ± 0.479

APPENDIX 5

ABUNDANCE AND RELATIVE ABUNDANCE VALUE OF ANIMAL ENCOUTERED DURING THE WET SEASON IN THE STUDY AREA

S/N	Code	Total No. of Animal	Abundance	Rela. Abd.± Se
1	ACAF	68	0.24	0.178 ± 1.651
2	AGAG	18	0.07	0.046 ± 0.583
3	ANLE	391	1.35	1.018± 19.318
4	ARCI	15	0.05	0.040 ± 0.590
5	ARNI	1752	5.97	4.492± 23.367
6	ATCH	8	0.02	0.020 ± 0.216
7	BIGA	32	0.11	0.084 ± 1.729
8	BOHA	6	0.02	0.016 ± 0.276
9	BOLI	13	0.05	0.034 ± 0.558
10	BUIB	938	3.25	2.442± 20.485
11	BUSE	33	0.11	0.086 ± 1.429
12	CASP	81	0.28	0.212 ± 2.820
13	CEGR	15	0.05	0.040 ± 0.800
14	CESE	235	0.81	0.612 ± 9.636
15	CEMA	63	0.22	0.164 ± 9.178
16	CERU	15	0.05	0.040 ± 0.800
17	CESP	287	0.99	0.748 ± 3.501
18	CEMO	38	0.13	0.098 ± 1.863
19	CERD	36	0.12	0.094 ± 1.054
20	CIAB	43	0.15	0.112 ± 1.977
21	CICA	2	0.01	0.006 ± 0.160
22	CIGA	153	0.53	0.398 ± 8.265
23	CLGL	15	0.05	0.040 ± 0.698
24	CLJA	8	0.02	0.020 ± 0.397
25	CLLE	16	0.06	0.042 ± 0.981
26	COAB	25	0.09	0.066 ± 1.145
27	COCY	64	0.22	0.166 ± 1.934
28	COCO	33	0.11	0.086 ± 1.001
29	COAL	553	1.91	1.440 ± 9.642
30	COCR	33	0.11	0.086 ± 1.435
31	CRGA	198	0.68	0.516 ± 1.698
32	CRPI	50	0.17	0.130 ± 2.124
33	CYPA	132	0.46	0.344 ± 3.257
34	DEVI	34	0.12	0.088 ± 0.725
35	DEVD	48	0.17	0.126 ± 3.830
36	DEDO	8	0.02	0.020 ± 0.491
37	DEFU	56	0.19	0.146 ± 1.676
38	EPEB	143	0.5	0.72 ± 3.246
39	ERPA	105	0.36	0.238 ± 3.716
40	ESME	14	0.05	0.036 ± 0.762
41	EUOR	73	0.25	0.190 ± 2.691
42	EUMA	64	0.22	0.166 ± 2.691
43	FRBI	1105	3.38	2.878 ± 9.818

44	FROC	106	0.37	0.276 ± 3.783
45	GEMA	5	0.02	0.014 ± 0.399
46	GETR	1	0	0.002 ± 0.079
47	GYAN	2	0.01	0.006 ± 0.160
48	HALE	8	0.02	0.020 ± 0.431
49	HAMA	18	0.06	0.046 ± 0.571
50	HASE	14	0.05	0.036 ± 0.696
51	HAVO	53	0.18	0.138 ± 3.888
52	HEPU	42	0.15	0.110 ± 1.507
53	HISE	57	0.2	0.148 ± 3.012
54	HISG	22	0.08	0.058 ± 0.798
55	HYMI	108	0.37	0.282 ± 4.048
56	HYCR	12	0.04	0.032 ± 0.565
57	ININ	45	0.16	0.118 ± 2.334
58	INMI	448	1.55	1.166± 16.242
59	KAMO	144	0.5	0.376± 15.0.32
60	LASE	60	0.21	0.156 ± 2.211
61	LAAR	11	0.04	0.028 ± 0.478
62	LASP	34	0.12	0.088 ± 1.723
63	LEST	79	0.27	0.206 ± 1.931
64	LECA	549	1.9	1.430 ± 1.921
65	LOBI	105	0.36	0.274 ± 6.240
66	LOCU	3389	11.7	8.826142.035
67	LOSI	59	0.21	0.154 ± 1.014
68	LYVE	21	0.08	0.054 ± 1.014
69	MACR	7	0.02	0.018 ± 0.343
70	MEAL	6	0.02	0.016 ± 0.344
71	MENU	120	0.42	0.312 ± 9.156
72	MEMA	396	1.37	1.032 ± 11.618
73	MEMU	51	0.18	0.132 ± 2.369
74	MICA	19	0.07	0.050 ± 0.845
75	MIMI	189	0.65	0.492 ± 4.471
76	MOFL	170	0.59	0.442 ± 7.511
77	MUOB	24	0.08	0.062 ± 1.130
78	MUMI	36	0.12	0.094 ± 1.550
79	MUVI	26	0.09	0.068 ± 1.013
80	NAME	15	0.05	0.040 ± 0.410
81	NUME	913	3.16	2.376± 17.050
82	PHAT	10	0.04	0.026 ± 0.715
83	PHTR	321	1.11	0.836± 18.273
84	PLCU	2296	7.95	5.980± 51.929
85	PLME	407	1.41	1.060± 15.593
86	POSU	31	0.11	0.080 ± 1.421
87	POSE	80	0.28	0.208 ± 2.765
88	PORA	15	0.05	0.040 ± 0.645
89	PRRU	8	0.02	0.020 ± 0.558
90	PRAU	35	0.12	0.092 ± 1.290
91	PRST	34	0.12	0.088 ± 0.866
92	PSSI	5	0.02	0.014 ± 0.249
93	PSSP	35	0.12	0.092 ± 0.879

94	PYBA	33	0.11	0.086 ± 1.095
95	PYSE	1	0	0.002 ± 0.079
96	RANA	24	0.08	0.006 ± 0.774
97	ROSM	427	1.48	1.112± 17.315
98	SCPL	77	0.27	0.002 ± 3.158
99	SCUM	2	0.01	0.006 ± 0.161
100	SPME	333	1.15	0.868± 15.627
101	STDE	21	0.08	0.054 ± 1.107
102	STSE	53	0.18	0.138 ± 1.554
103	STSQ	113	0.39	0.294 ± 4.271
104	STTU	264	0.91	0.688 ± 7.324
105	STVI	28	0.1	0.078 ± 1.324
106	TAKE	25	0.09	0.066 ± 0.534
107	THSW	7282	25.2	18.964± 37.567
108	TOER	10	0.04	0.026 ± 0.455
109	TONA	54	0.19	0.140 ± 2.082
110	TRSC	305	1.06	0.794 ± 3.059
111	TRAU	875	3.03	2.278 ± 9.162
112	TUPE	59	0.2	0.154 ± 2.055
113	TURE	14	0.05	0.036 ± 0.600
114	TYAL	2	0.01	0.006 ± 0.161
115	VEEX	5	0.02	0.014 ± 0.249
116	VENI	46	0.16	0.120 ± 1.938
117	VIMA	4	0.01	0.010 ± 0.181
118	VICI	214	0.74	0.588 ± 9.531
119	XEER	740	2.56	1.928 ± 6.029
120	XESP	140	0.48	0.364 ± 7.164
121	ZOSE	100	0.35	0.260 ± 7.145

APPENDIX 6

ABUNDANCE AND RELATIVE ABUNDANCE VALUE OF ANIMAL ENCOUTERED DURING THE DRY SEASON IN THE STUDY AREA IN THE STUDY AREA

S/N	Code	Total No. of Animal	Abundance	Rela. Abd. ± Se
1	ACAF	85	0.17	0.111 ± 2.554
2	AGAG	44	0.09	0.057 ± 1.541
3	ANLE	657	1.31	0.856 ± 0.289
4	ARCI	21	0.04	0.027 ± 0.799
5	ARNI	3169	6.31	4.126 ± 0.289
6	ATCH	15	0.03	0.020 ± 0.445
7	BIGA	37	0.07	0.048 ± 1.906
8	BOHA	8	0.02	0.010 ± 0.349
9	BOLI	26	0.05	0.034 ± 0.895
10	BUIB	2337	4.05	30.43 ± 5.412
11	BUSE	42	0.08	0.055 ± 1.654
12	CASP	153	0.3	0.199 ± 4.342
13	CEGR	35	0.07	0.046 ± 0.966
14	CESE	369	0.73	0.481 ± 12.663
15	CEMA	112	0.22	0.146 ± 9.379
16	CERU	21	0.04	0.027 ± 0.964
17	CESP	456	0.91	0594 ± 8.302
18	CEMO	84	0.16	0.109 ± 3.396
19	CERD	58	0.11	0.076 ± 1.596
20	CIAB	53	0.11	0.069 ± 2.375
21	CICA	9	0.02	0.012 ± 0.444
22	CIGA	210	0.43	0.273 ± 9.398
23	CLGL	29	0.06	0.38 ± 1.152
24	CLJA	50	0.1	0.065 ± 2.206
25	CLLE	54	0.11	0.070 ± 1.848
26	COAB	75	0.15	0.098 ± 2.475
27	COCY	41	0.08	0.053 ± 1.352
28	COCO	966	1.92	1.258 ± 19.545
29	COAL	58	0.12	0.075 ± 2.322
30	COCR	334	0.66	0.435 ± 5.632
31	CRGA	67	0.13	0.087 ± 2.566
32	CRPI	190	0.38	0.087 ± 5.130
33	CYPA	132	0.46	0.344 ± 3.257
34	DEVI	59	0.12	0.077 ± 1.356
35	DEVD	88	0.18	0.115 ± 5.171
36	DEDO	27	0.05	0035 ± 1.291
37	DEFU	98	0.19	0.128 ± 2.891
38	EPEB	285	0.57	0.371 ± 6.243
39	ERPA	196	0.39	0.255 ± 30.027
40	ESME	21	0.04	0.027 ± 0.928
41	EUOR	73	0.15	0.095 ± 3.173
42	EUMA	87	0.17	0.113 ± 3.512
43	FRBI	2200	4.38	2.865 ± 37.590
44	FROC	112	0.22	0.146 ± 4.493

45	GEMA	5	0.01	0.007 ± 0.415
46	GETR	2	0	0.003 ± 0.117
47	GYAN	6	0.01	0.008 ± 0.370
48	HALE	8	0.02	0.010 ± 0.468
49	HAMA	19	0.04	0.025 ± 0.710
50	HASE	18	0.01	0.073 ± 2.677
51	HAVO	56	0.11	0.073 ± 4.078
52	HEPU	59	0.12	0.077 ± 1.902
53	HISE	67	0.13	0.087 ± 3.381
54	HISG	46	0.09	0.060 ± 1.627
55	HYMI	185	0.37	0.241 ± 6.148
56	HYCR	49	0.1	0.064 ± 1.659
57	ININ	56	0.11	0.073 ± 2.667
58	INMI	640	1.27	0.833 ± 21.23
59	KAMO	240	0.48	0.313 ± 5.036
60	LASE	73	0.15	0.095 ± 2.779
61	LAAR	20	0.04	0.026 ± 0.693
62	LASP	72	0.15	0.094 ± 3.175
63	LEST	139	0.28	0.181 ± 3.049
64	LECA	1006	2	1.310 ± 16.869
65	LOBI	156	0.31	0.203 ± 7.305
66	LOCU	5667	11.3	0.739 ± 0.170
67	LOSI	109	0.22	0.142 ± 3.119
68	LYVE	66	0.13	0.086 ± 1.364
69	MACR	14	0.03	0.018 ± 0.504
70	MEAL	17	0.03	0.022 ± 0.846
71	MENU	120	0.42	0.28 ± 9.631
72	MEMA	657	1.31	0.856 ± 17.753
7	MEMU	68	0.14	0.089 ± 2.832
74	MICA	19	0.04	0.025 ± 0.952
75	MIMI	322	0.64	0.419 ± 8.051
76	MOFL	302	0.6	0.393 ± 13.073
77	MUOB	36	0.07	0.047 ± 1.465
78	MUMI	43	0.09	0.056 ± 1.807
79	MUVI	103	0.2	0.134 ± 2.207
80	NAME	25	0.05	0.033 ± 0.691
81	NUME	1571	3.13	2.046 ±32.467
82	PHAT	32	0.06	0.042 ± 1.181
83	PHTR	498	0.99	0648 ± 21.360
84	PLCU	3884	7.73	5.057 ± 87.342
85	PLME	637	1.27	0.829 ± 21.286
86	POSU	51	0.1	0.066 ± 1.956
87	POSE	82	0.16	0.107 ± 3.324
88	PORA	19	0.04	0.025 ± 0.710
89	PRRU	27	0.09	0.035 ± 1.178
90	PRAU	52	0.1	0.068 ± 1.770
91	PRST	64	0.13	0.083 ± 1.580
92	PSSI	12	0.03	0.016 ± 0.571
93	PSSP	83	0.17	0.108 ± 2.462
94	PYBA	40	0.08	0.052 ± 1.372

95	PYSE	1	0	0.001 ± 0.083
96	RANA	40	0.08	0.052 ± 1.372
97	ROSM	1186	2.36	1.544 ± 63.180
98	SCPL	108	0.21	0.141 ± 4.278
99	SCUM	5	0.01	0.007 ± 0.298
100	SPME	496	0.99	0.646 ± 18.199
101	STDE	30	0.06	0.039 ± 1.247
102	STSE	143	0.28	0.186 ± 6.165
103	STSQ	165	0.33	0.215 ± 5.254
104	STTU	422	0.84	0.549 ± 7.803
105	STVI	48	0.1	0.063 ± 1.787
106	TAKE	37	0.07	0.048 ± 0.864
107	THSW	12624	25.1	0.164.± 0.190.
108	TOER	36	0.07	0.047 ± 1.031
109	TONA	123	0.24	0.160 ± 3.116
110	TRSC	481	0.96	0.626 ± 2.934
111	TRAU	1471	2.93	1.915 ± 30.852
112	TUPE	84	0.16	0.109 ± 2.793
113	TURE	34	0.07	0.044 ± 0.993
114	TYAL	3	0.01	0.004 ± 0.185
115	VEEX	8	0.02	0.010 ± 0.329
116	VENI	55	0.11	0.072 ± 2.252
117	VIMA	36	0.07	0.047 ± 1.681
118	VICI	350	0.7	0.456 ± 12.314
119	XEER	1128	2.24	1.469 ± 20.513
120	XESP	257	0.51	0.335 ± 10.150
121	ZOSE	106	0.21	0.138 ± 7.784

APPENDIX 7: CHEMICAL AND MECHANICAL ANALYSIS OF 48 PLOTS SAMPLED AT THE PERMANENT SITE OF THE UNIVERSITY OF AGRICULTURE, ABEOKUTA OGUN STATE

PLOT	SAND	SILT	CLAY	GRAVEL	O.M	N	P	K	Mg	Ca	Na
NO.	-----------	---------	(%)--	-----------	--------	-------	(PPM)-	---------	--------	(Cmolkg-1)	--------
1	87.8	6	6.2	21	3.14	0.18	4.7	0.15	0.97	3.23	0.23
2	89.2	5.3	5.5	28.1	3.28	0.19	2.4	0.92	1.13	3.29	0.2
3	85.3	3.7	11	22.4	1.45	0.89	4.3	0.79	1.19	3.13	0.21
4	80.8	22.8	6.4	10.3	3.64	0.21	0.7	0.21	0.91	3.09	0.32
5	99	5.6	6.4	23.7	5.12	0.3	0.6	0.16	0.89	3.61	0.39
6	96.1	4.8	6.4	13.5	3.45	0.2	1.6	0.22	1.06	3.46	0.31
7	90.3	2.8	9.1	31.3	1.17	0.07	5.7	0.36	1.13	1.91	0.2
8	57	7.3	6.9	29.7	1.64	0.09	3.7	0.71	1.08	3.33	0.22
9	90.4	3.3	5.7	26.6	2.67	0.15	4.1	0.95	0.88	3.65	0.23
10	87.6	3.2	5.3	30	4.38	0.25	6.4	0.75	1.53	3.42	0.3
11	95.6	5.2	4.2	21.8	1.28	0.07	5	0.47	0.79	2.94	0.21
12	56.4	4	9.3	27.9	1.28	0.27	0.5	0.61	1.12	3.38	0.4
13	94.4	3.5	9.6	17.2	4.71	0.13	4.8	1.02	1.14	2.81	0.38
14	-94.4	2	5.5	29.4	2.24	0.11	2.5	0.9	1.27	3.48	0.38
15	94.4	2.6	13.5	21.8	1.69	0.07	1	0.19	1.42	4	0.27
16	99.7	2.9	4	13.5	3.41	0.23	1.7	0.53	1.08	3.01	0.26
17	92	2.4	8.4	22	1.76	0.11	7.5	0.23	1.26	2.48	0.2
18	83.3	2.9	5.6	27.3	3.52	0.22	1.2	0.69	0.99	2.43	0.23
19	99.3	2.4	10.3	33.7	2.77	0.16	5.7	0.28	1.82	4.74	0.3
20	84.5	9.7	8.3	29.6	3.6	0.21	7.8	0.83	1.93	6.1	0.26

APPENDIX 8

PLOT NO.---	SAND ------ (%)	SILT ------	CLAY --------------	GRAVEL ------------	CLASSIFICATION
1	87.8	6	6.2	21	Gravelly loamy sand
2	89.2	5.3	5.5	28.1	Gravelly loamy sand
3	85.3	3.7	11	22.4	Gravelly loamy sand
4	80.8	12.9	6.4	10.3	Slightly ly loamy sand
5	88	5.6	6.4	23.7	Gravelly loamy sand
6	86.1	4.8	9.1	13.5	Slightly Gravelly loamy sand
7	90.3	2.8	6.9	31.3	Gravelly sand
8	87	7.3	5.7	29.7	Gravelly loamy sand
9	91.4	3.3	5.3	26.6	Gravelly sand
10	87.6	8.2	4.2	30	Gravelly loamy sand
11	85.6	5.2	9.2	21.8	Gravelly loamy sand
12	86.4	4	9.6	27.9	Gravelly loamy sand
13	90.7	3.5	5.9	17.2	Gravelly sand
14	79.5	7	13.5	29.4	Gravelly loamy sand
15	94.4	1.6	4	21.8	Gravelly loamy sand
16	89.7	1.9	8.4	13.5	Gravelly loamy sand
17	92	2.4	5.6	22	Gravelly sand
18	88.8	0.9	10.3	27.3	Gravelly sand
19	89.3	2.4	8.3	33.7	Gravelly sand
20	84.5	9.7	5.8	29.6	Gravelly loamy sand

APPENDIX 9

Plate 1. Picture of Cattle Egret *(Bulbulcus ibis*) seen on the site.

APPENDIX 10

Plate2. Picture of expended cartridge located close to the study site.

APPENDIX 11

Plate 3: Illegal grazing on the site

APPENDIX 12

Plate 4: Wild fire at the edge of the site