# Status of forest reserves (savanna woodland) biodiversity and rural livelihoods in Gombe state

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## Abstract

This study examines the role forest reserves in biodiversity conservation and its implications on rural livelihoods in Gombe state. Wawa, Kanawa and Lembi Forest Reserves were sampled out of the 30 so called forest reserves in the state. 100 m transects were laid at 10m interval in each of the three sampled forest reserves, in order to collected information on tree density. Soil samples were collected, 0-20cm depth along the whole length of the transect lines, for determination of soil macro fauna. The results revealed that 89% respondents were aware of the existence of these forest reserves. On survey of livelihood support activities undertaken within the Forest reserves 34.8% of respondents used the forest reserves for fuel wood extraction; 16% for farming and fruits collection respectively. A survey on changes noticed in species composition of the Forest reserves indicated that 85% of respondents had observed changes in species composition. Respondents causes of vegetation degradation shown that 42.5% of the respondents farming practices has caused the decreased in area extents of these forest reserves while fuel wood extraction represents 19% respectively. Twenty three different trees Species distributed within 16 families were found within the reserves. The most common family are Combretaceae Caeslpiniaceae, Mimosacea and Meliaceae. The results further indicated that 32 species of macro fauna were found in Wawa forest reserve compared to 18 and 9 macro fauna species found Kanawa in Lembi Forest reserve. It was suggested that the reminding patches of Forest reserve in state should be closed for exploitation for at least ten years by the state Directorate of forestry, to enable the forest regenerate and for the soil to regain its fertility status.

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## 1. Introduction

According to ITTO (2007) de reservation, lack of coherent forest policy, prevalence of illegal logging and harvest of Non Timber Forest Products (NTFPs), chronic under-funding and under-staffing of relevant government ministries, departments and agencies (MDAs), conflicting roles among the three tiers of government, excessive bureaucracy, lack of harmony and inter-sectoral coordination and overall absence of reliable data for planning and implementation of forest development and regeneration activities are the constraints to sustainable forest management and biodiversity conservation in Nigeria.

Although, biodiversity and tree based assets are undervalued in national accounting, and grossly under-invested in development decision making, the potential contributions of forests to the national economy cannot be over emphasized. Adekunle (2005) stated that some researchers have reported the potentials of tree and animal species in the forest ecosystems and over 150 indigenous woody plants have been noted for their edible products for human and livestock consumption. It is estimated that more than 15 million people in Sub-Saharan Africa earn their cash income from forest-related enterprises such as fuel wood and charcoal sales, small-scale saw-milling, commercial hunting and handicraft (FAO, 2010). In addition, between 200,000 and 300,000 people are directly employed in the commercial timber industry (Lazarus, 2015).

In Nigeria, forests reserves provide livelihood for people living in and around them and serve as vital safety nets for the rural poor; however forest resources are being depleted at alarming rates. Therefore, Man's incursions into the original forest for the purpose of development has resulted in biodiversity loss thereby increasing reduction in the available forest reserves, loss and extinction of flora and fauna with a consequent decline in food with an expected long term effect from climate change (Saha, and Guru, 2003).

The State Forestry Departments in Nigeria are the most important institutions in forest management in the country because the constitution grants them the sole right to manage the country's forest resources, not on behalf of the country, but rather, on behalf of their specific states (World Bank, 2005). However, some salient concerns, ranging from 'ownership issue' through 'definition of roles' to 'management right and tenure,' which have been left largely unresolved among the federating units (Federal, State and Local government) since the commencement of democracy in 1999, constitute serious impediments toward tackling large scale biodiversity loss.

There are 30 gazetted forest reserves that are located in different parts of Gombe state, constituting 1597.38 square kilometers or representing only about 9.1% of the total land area of the state (Mayomi et al., 2015).This percentage is quite low and falls short of the internationally recommended standard of 25 percent (Omiyale, 2001). This forest reserves only exist on map of the state but in reality most have been de reserved and hence will affect biodiversity functions. It is against this background that this research aimed at examines the role forest reserves in Gombe state in biodiversity conservation and its implications on rural livelihoods.

The objectives of this study were:

i)      To estimate the diversity of woody species and macro fauna in the study areas.

ii)     To compare the status of biodiversity in the reserved and de reserved forest areas.

## 2. The study area and methodology

### 2.1. Study area

The study was carried out in Gombe State (Figure 1), North-Eastern Nigeria. It is located between latitudes 9° 30" to 11°30"N and Longitudes 9° 30" and 11° 35" E, and occupies a total land area of about 17,258 km², with a projected population of 2,857,042 (N.P.C, 2010). It is bordered by Bauchi State to the west; Yobe State to the north, Borno State to east and Adamawa State to the south.
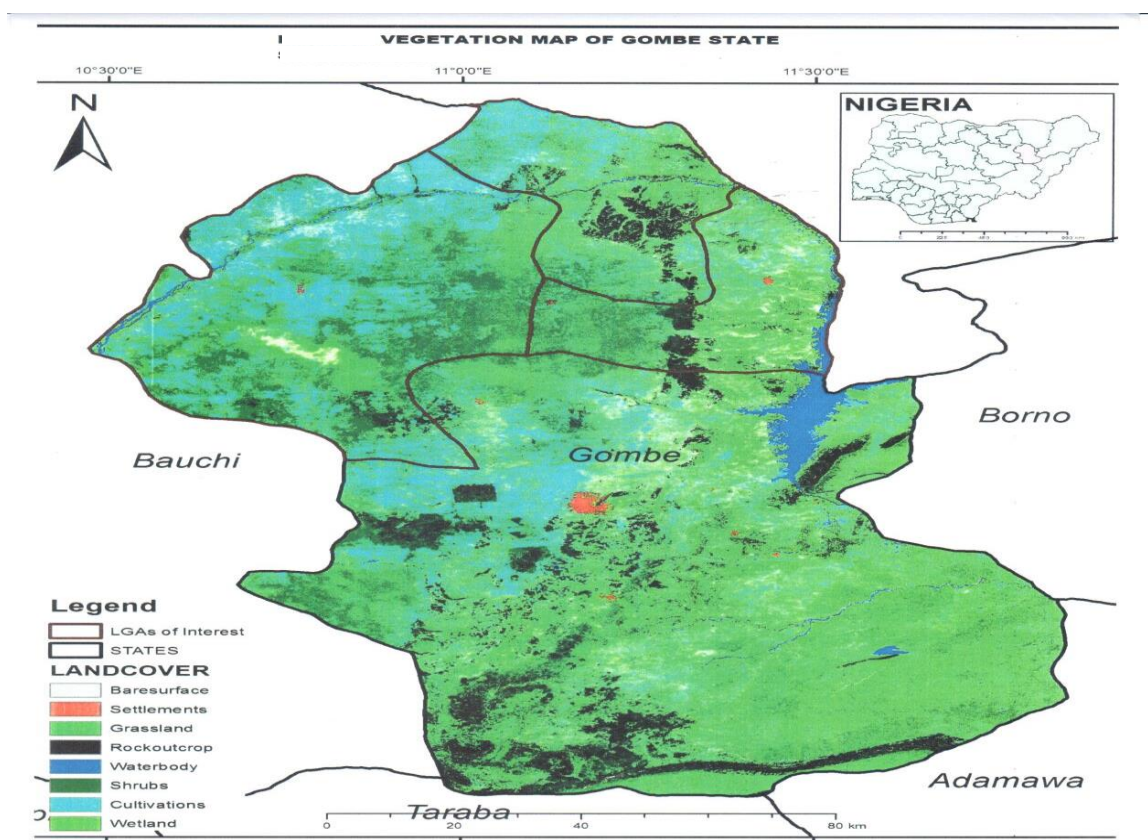


Figure I. Gombe state Landuse/ Land cover (Source: Ikusemoran, et al., 2015)

### *2.1.1. Location of the forest reserves*

This research was carried out in Wawa Zange, Kanawa and Lembi Forest Reserves in Gombe State. These Forest Reserves were gazetted in 1962, 1953 and 1960 respectively. Wawa forest reserve lies between latitude $10^0$ 49 ' 22.7"N to longitudes$10^0$ 46' 23" and is located in Dukku and Nafada local government areas occupying total area of 779.70 km², the Kanawa forest reserve covers an area of 5, 13 km². It is located between latitude$11^0$ 18' N to longitude $10^0$ 16"E, in Yamaltu / Deba LGA, and the Lembi forest reserve is located between latitudes to longitude $10^0$ 10"N to $11^0$ 06" E, in Akko LGA (Table I), the original size was 36.4 km², however approval was granted for its de reservation by the then governor of the state in August 2006, following a community request, leaving only approximately 10 hectares as herbal heritage site.

The reserves are dominated by Sudan Savannah ecological zone with concentration of wood lands in the south east and south western parts (Figure 2). The vegetation is typically a light closed canopy, with shrubs and a sparse growth of grass. There is a woodland savannah of Gombe Hills and that of Wawa, tree and shrub land of Kaltungo and Dukku. Another vegetation type includes stunted shrubs and trees 4.87 m – 6.09 m high. The natural flora, fauna, important birds and wildlife have declined and are on the verge of total extinction in Gombe state. Tree species found in these reserve include but not limited to; *Acacia spp, Anogeisus leiocarpus, Combretum spp, Detarium microcarpum, Entanda Africana, Prosopsis Africana,Raphia sudanica, Sterculia setigera,Vitex doniana, Vitaleria paradoxum, Khaya senegalensis, Parkia biglobosa, Ficus spp, and Ximenia Americana* km² (Hashidu, 2015)*.*

## 2.2. Material and methods

Based on the preliminary survey carried out, Wawa, Kanawa and Lembi Forest Reserves were sampled to constitute the study area. In order to obtain a representative sample, fifty (50) transects in Wawa forest reserve based on its size (779.70 km²); five (5) transects in Kanawa Forest Reserve relative to the size of 5.13km2 and 20 transects were laid in Lembi Forest Reserve relative to its size (36.30 km²) respectively. In each case,100 m transects were laid, ten (10) points of 10m interval, were pegged along each transect line,. Soil samples were collected, 0-20cm depth along the whole length of the transect lines, for determination of soil macro fauna. Data collected include information on tree density. Socio-economic factors as well as Soil macro fauna, responsible for the present status of biodiversity of the forest reserves understudy.

### *2.2.1. Estimation of species list, relative density and diversity*

The point centred Quarter (PCQ) method, was employed this study. The procedure consists of setting up one or series of baselines through the plant community running either north-south or east-west. Random distances were measured along these lines, thus locating random points. An imaginary line was drawn perpendicular to the baseline from each of the random points starting at the transect pole, the pointer placed into the ground at the tip of the boot, thus marking the sampling point. The distance from the pointer to the plant measured, species name was noted and the diameter at Breast Height (dbh) measurement was

recorded using tapes on to trunks at 1.3m high. This procedure was repeated for 10 points along each transect.

i) Relative frequency   =   $\underline{\text{No. of occurrence of individual species}}$ × 100
                                    Total no. individuals in the study area 1                                    1

ii) Relative density      =   $\underline{\text{No. individuals of a species}}$   ×   100
                                    Total area          1                                                              2

iii) Relative dominance  =    $\underline{\text{Total basal area of individual species}}$   ×   100
                                    Total basal area of all species in the study are1                      3

iv) Importance Value Index  =  $\underline{\text{RF+RDO+RD}}$
                                              3                                                                              4

where RF= Relative frequency, RDO= Relative dominance, RD= relative density

vi) Plant Diversity was determined using Simpson's Index which is given by the formula:

$$D = 1 - \left(\frac{\sum n(n-1)}{N(N-1)}\right)$$                                                                 5

where    D = diversity index
         N = total no. of individual plants
         n = number of individuals per species
         $\sum n$ =Summation

### 2.2.2. Soil macro fauna extraction and identification

The method of hand sorting was used to get underground macro fauna (James, 2012). Soil macro fauna were identified by spreading the soil sample on a flat board and sorting out all invertebrates. Identification of soil macro fauna was done with reference to some books, including Nielsen et al. (2010).

A total number of 200 questionnaires were administered in the study areas and 50 questionnaires to the State/local Govt. Forestry officers/ technical staff. Respondents were randomly chosen using stratified random sampling procedure. Only heads of household were interviewed on the premise that they take daily decisions for the sustenance of the household members. The number of questionnaires administered in each community (Kanawa, Wawa and Lembi) was based on the population using method of proportional allocations technique.

The formulae are stated as follows.

$$N = \frac{nh \times n}{H}$$                                                                              6

where  nh = population of the people in each community.

n   =   total no. of questionnaires to be administered

H   =   total population in the study areas.

N   =   no. of questionnaires to be administered in each community of  the area of study.

### 2.2.3. Data processing and analysis

i   Frequency and percentage tables were used to interpret the  data. The socio-economic survey data was subjected to both qualitative and quantitative using, statistical package for Social Sciences (SPSS 1999).

ii   Student's t-test was used to compare the species and macro fauna diversity in the two reserves,

$$t = \frac{\overline{X_A} - \bar{X}_B}{\sqrt{\frac{S^2(n_A - n_B)}{(n_A)(n_B)}}} \qquad\qquad 7$$

where:

$X_A$ and $X_B$ = arithmetic means for groups A and B

$n_A$ and $n_B$ = number of observations in groups A and B (note that $n_A$ and $n_B$ do not have to be the same).

$S^2$ = pooled within – group variance (for independent samples with equal variance)

$S^2$ is computer as follows:

$$S^2 = \frac{SS_A + SS_B}{(n_A - 1) + (n_B - 1)} \qquad\qquad 8$$

## 3. Result and discussions

### 3.1. Biodiversity status of the forest reserves

The results of respondents interviewed on their awareness of existence of Forest Reserve in their areas indicate that 89% revealed they were aware, 10% of all respondents were not aware, 1%, had no idea at all (Table 2). 20.4%, 25% and 34% of the respondents further stated that the Forest Reserves are being managed by individual, communities and state government respectively. This up – bottom types of forest management system contributed to de reservation of forest reserves in the state.

On survey of livelihood support activities undertaken within the Forest reserves 34.8% of respondents used the forest reserves for fuel wood extraction; 16% for farming and frits collection respectively while 10 and 22% of the respondents' uses for the forest reserves for wood carving and construction materials. A

survey on changes noticed in species composition of the Forest reserves indicated that 85% of respondents had observed changes in species composition while only14.5% has not noticed any change.

Responses to the causes of vegetation degradation shown that 42.5% of the respondents farming practices has caused the decreased in area extents of theses forest reserves while 28.5%, stated that vegetation degradation is caused by bush fire, and fuel wood extraction represents 19% and overgrazing 10% respectively (Table 2). For respondents perceptions on current status of these forest reserves 43.0% indicated that the forests have been de reserved as result of encroachment by farmer, while 13% stated that the forests still exist.

In response to the factors responsible for depletion of the Forest reserves 44% said it was due to over population, while 33.5% of respondents revealed it was due to poverty, and 22.5% indicated it was due to illiteracy level (Table 2). Respondents interviewed on whether depletion of Forest resources has led to poverty, 42.5% strongly agreed; 28.5% agreed; 14% disagreed while 15% of the respondents strongly disagreed (Table 2).

**Table 1.** List of Forest Reserves and their Current Status in Gombe State

| S/N | Name of reserve | Location (LGA) | Year of estab | Area (km2) | Status |
|-----|-----------------|----------------|---------------|------------|--------|
| 1 | Abba Isari | Funakaye | 1959 | 9.3 | Illegally De-reserved |
| 2 | Akko | Akko | 1927 | 64.75 | Part illegally De-reserved |
| 3 | Alin Magini | Akko | 1956 | 1.8 | Encroached |
| 4 | Bage | Funakaye | - | 23.6 | Encroached |
| 5 | Billiri Hills | Billiri | 1957 | 40.9 | Encroached |
| 6 | Bodor Hills | Funakaye | - | 29.1 | Encroached |
| 7 | Dukku | Dukku | 1961 | 49.9 | Encroached |
| 8 | Dutsin Amina | Akko | 1957 | 4 | Encroached |
| 9 | Gadam | Kwami | 1953 | 42.5 | De-reserved |
| 10 | Garko | Akko | 1956 | 7.3 | Encroached |
| 11 | Garko Meri | Akko | 1956 | 32.4 | Encroached |
| 12 | Jagali | Y/Deba | 1971 | 55.6 | Encroached |
| 13 | Jauro Tukur | Akko | 1956 | 1.4 | Encroached |
| 14 | Kaltungo Hills | Kaltungo | 1956 | 4.5 | Encroached |
| 15 | Kaltungo South | Kaltungo | 1968 | 7.9 | Encroached |
| 16 | Kalshingi Hills | Akko | 1956 | 47.1 | Encroached |
| 17 | Kanawa | Y/Deba | 1953 | 5.13 | Exist |
| 18 | Kumo | Akko | 1953 | 5.1 | Encroached |
| 19 | Lembi | Akko | 1960 | 36.3 | Illegally De-reserved |
| 20 | Liji Hills | Akko/Gombe | 1961 | 7.8 | Illegally De-reserved |

| 21 | Nafada | Nafada | 1971 | 47.7 | encroached |
|----|--------|--------|------|------|------------|
| 22 | Ribadu | Funakaye | 1960 | 22.1 | Encroached |
| 23 | Shebangel Hills | Y/Deba | 1955 | 3.1 | Part De-reserved |
| 24 | Tongo | Funakaye | 1958 | 6.5 | Encroached |
| 25 | Wawa | Dukku/FKY | 1962 | 779.7 | Encroached |
| 26 | Wuro Bamusa | Gombe/Akko | 1965 | 1.5 | De-reserved |
| 27 | Wuro Biriji | Gombe/Akko | 1955 | 2.9 | De-reserved |
| 28 | Yamaltu | Y/Deba | 1953 | 37.5 | De-reserved |
| 29 | Tukulma | Akko | 1956 | 293.3 | De-reserved |
| 30 | Dundadu | Akko | 1956 | 50.7 | De-reserved |

*Source: Ministry of Environment, Gombe (2013)*

**Table 2.** Forest Reserve Biodiversity status

| Parameters | Frequency | Percentage |
|------------|-----------|------------|
| **Awareness of existence of Forest reserve** | | |
| **Yes** | 271 | 89 |
| **No** | 24 | 10 |
| **No idea** | 5 | 1 |
| Total | **300** | **100** |
| | | |
| **Management of Forest reserves** | | |
| **Individuals** | 33 | 20.4 |
| **Communities** | 126 | 25.6 |
| **State Govt.** | 100 | 34 |
| **Fed. Govt.** | 15 | 12 |
| **NGOs** | 26 | 8 |
| Total | **300** | **100** |
| | | |
| **Livelihood support activities within the reserves** | | |
| **Fuel wood** | 127 | 34.8 |
| **Fruits collection** | 51 | 16.8 |
| **Farming** | 54 | 16 |
| **Wood carving** | 47 | 10 |
| **Constructional material** | 20 | 22.4 |
| Total | **300** | **100** |
| | | |
| **changes in species composition in Forest reserves** | | |
| **Yes** | 265 | 76 |

| | | |
|---|---|---|
| **No** | 29 | 23.6 |
| **No idea** | 6 | 0.4 |
| Total | **3 00** | **100** |

| **Historical knowledge of vegetation degradation** | | |
|---|---|---|
| **Yes** | 210 | 76 |
| **No** | 79 | 23.6 |
| **No idea** | 11 | 0.4 |
| Total | **300** | **100** |

| **Causes of vegetation degradation** | | |
|---|---|---|
| **Bush fire** | | |
| **Overgrazing** | 47 | 28.5 |
| **Farm Encroachment** | 41 | 10 |
| **Fuel wood** | 123 | 42.5 |
| Total | **98** | **19** |

| **Respondents' perception of present condition of the Forest reserves** | | |
|---|---|---|
| **Encroached** | 123 | 21.2 |
| **De reserved** | 106 | 29.2 |
| **Existing** | 46 | 30.4 |
| **Don't know** | 25 | 19.2 |
| Total | **300** | **100** |

| **Factors responsible for depletion of Forest resources in the reserves** | | |
|---|---|---|
| **Population** | 128 | 44 |
| **Poverty** | 107 | 33.5 |
| **Illiteracy** | 65 | 22.5 |
| Total | **300** | **100** |

| **Depletion of Forest resources has led to increased poverty** | | |
|---|---|---|
| **Strongly agree** | 125 | 42.5 |
| **Agree** | 77 | 28.5 |
| **Disagree** | 58 | 14 |
| **Strongly disagree** | 40 | 15 |
| Total | **300** | **100** |

## 3.2. Stakeholder survey on forest conservation in Gombe state

The results of Forest Reserves conservation and management in Gombe state reveals that the Ministry of Environment and Forest Resources is sole responsible for policy formulation administration and funding of Forest Reserves, through the Directorate of Forestry and Wildlife Management. The results of the assessment of the manpower status of the state forestry Directorate reveals 84.4%, indicated that the directorate is adequately staffed, 2 respondents opines that it is overstaffed, and 10% responded that the directorate is understaffed, (Table 3).

**Table 3.** Stakeholder Survey

| Parameters | Frequency | Percentage |
|---|---|---|
| **Manpower status of State Forestry Directorate** | | |
| **Adequate** | 42 | 84 |
| **Over staffed** | 2 | 4 |
| **Under staffed** | 5 | 10 |
| **Do not know** | 1 | 2 |
| **Total** | **50** | **100** |
| | | |
| **Role of State Forestry in Reserves protection** | | |
| **Yes** | 30 | 60 |
| **No** | 20 | 40 |
| **Total** | **50** | **100** |
| | | |
| **Availability of patrol vehicles and equipment** | | |
| **Yes** | 10 | 20 |
| **No** | 40 | 80 |
| **Total** | **50** | **100** |
| | | |
| **Managerial and Conservation problems in Forest reserves** | | |
| **Encroachment** | 39 | 78 |
| **Poaching** | 7 | 14 |
| **Harvesting** | 4 | 8 |
| **Total** | **50** | **100** |
| | | |
| **Whether budgetary allocation to state Forestry is adequate** | | |
| **Yes** | 18 | 36 |
| **No** | 12 | 24 |
| **Total** | **50** | **100** |

| **Whether state Forestry conducts annual survey of Reserves** | | |
|---|---|---|
| **Yes** | 6 | 12 |
| **No** | 44 | 88 |
| **Total** | **50** | **100** |

| **Acceptable land uses for future safeguard of Forest reserves** | | |
|---|---|---|
| **Agriculture** | 12 | 24 |
| **Pastoralism** | 9 | 18 |
| **Agro pastoralism** | 4 | 8 |
| **Agro Forestry** | 25 | 50 |
| **Don't know** | 0 | 0 |
| **Total** | **50** | **100** |

*Source: Field work (2016)*

For Survey of whether the Directorate of Forestry plays any role in protecting the Forest Reserves, a frequency 60% of the respondents opines that the directorate protects the forest, while 40% disagreed with the fact that the state forestry directorate is discharging its role of protecting the reserves. The results of availability of patrol vehicles shows that 80.0% indicated that there are no adequate patrol vehicles and equipment for the staff to effectively patrol the reserves; 20% indicated that there are adequate patrol vehicles and equipment, in the state Directorate of Forestry (Table 3). A Survey of the managerial and conservation problems existing in the forest reserves reveals 78.0%, indicated that the major problems of forest reserves are encroachment for farming reasons, 14% identified poaching and 8.0% attributed the problems to harvesting of NTFPs (Table 3). The results of survey on whether budgetary allocation to state Forestry is adequate to discharge the duties of protecting the Forest Reserves revealed 36% indicated adequately, while 22% opined inadequate budgetary allocation (Table 3). Respondents interviewed on whether state Forestry conducts annual survey and boundary demarcation as well as fire tracing of Forest Reserves revealed that 24% indicated that the state Forestry conducts annual survey and boundary demarcation as well as fire tracing of Forest Reserves, while 88% indicated that the state Forestry does not conduct annual survey, boundary demarcation and fire tracing of Forest Reserves.

Survey of the acceptable land uses in order to safeguard the Forest Reserves against further depletion, revealed that50% suggested adoption of Agro forestry system, as the only acceptable land use to be adopted in order to safeguards the forest reserves against future degradation, and 24% suggested Farming only, while 18% opted for pastoralism, and 8% supported Agro-pastoralism. The results of this survey therefore signified that the people in the neighbouring communities depend upon the forest reserves to obtain their economic livelihood; hence they would be ready to contribute towards the sustainability of the forest reserves.

## 3.3. Checklist of woody species in Wawa, Kanawa and Lembi forest reserves

A total of 36 tree species were encountered on the laid quadrants, along 25 transects within the three (Wawa, Kanawa and Lembi) forest reserves. Twenty three different trees

Species distributed within 16 families were found within the reserves. The results indicated that there were 20 species, belonging to 13 families with frequency of 255 trees in Wawa 200 trees in Kanawa Forest Reserve, while Lembi Forest Reserve had 15 different species, belonging to 9 families with frequency of 160 trees were recorded, (Table 4). The family Combretaceae had the highest number of species (ninety-five species) in three genera, followed by Caeslpiniaceae having sixty-five species in three genera, then Mimosaceae with fifty-one species belonging to four genera, this is followed by Meliaceae, with sixty species in two genera. Other families are Aracaceae with thirty species in one Genus, Sapotaceae had nine species in one Genus, Verbanaceae had five species in one Genus, the lowest being Anacardiaceae and Bombaceae each of which had two species belonging to same genus respectively, within the two forest reserves, as presented in Tables 9,10 and 11 respectively.

The results of biodiversity assessment in Wawa and Kanawa Forest Reserves indicated that *Anogeisus leiocarpus* has the highest frequency of 33 and relative frequency of 16.5% while *Albizia labeck, Entada Africana,* and, *Gmelina arboea,* recoded the lowest frequency of 1 each, with relative frequency of 0.5%. In Lembi Forest Reserve where *Detarium microcarpumda* has the highest frequency of 21 and relative frequency of 13.1% while *Acacia sayel* and,*Acacia siberiana* recoded the lowest frequency of 3 trees each, with relative frequency of 1.9% (Tables 5 and 6 and 7).

**Table 4.** Checklist of Woody Species in Wawa, Kanawa and Lembi Forest Reserves

| S/N | Species | Family | Forest reserve | | |
|-----|---------|--------|------|--------|-------|
| | | | Wawa | Kanawa | Lembi |
| 1 | *Acacia spp* | Mimosaceae | √ | √ | √ |
| 2 | *Albizia labbeck* | Fabaceae | √ | √ | X |
| 3 | *Anogeissus leiocarpus* | Combretaceae | √ | √ | √ |
| 4 | *Azadirachta indica* | Meliaceae | √ | √ | √ |
| 5 | *Cassia siemea* | Caesalpiniaceae | √ | √ | √ |
| 6 | *Ceiba pentandra* | Bombacaceae | √ | √ | √ |
| 7 | *Combrettum spp* | Combetaceae | √ | X | √ |
| 8 | *Detarium microcarpum* | Caesalpiniaceae | √ | √ | √ |
| 9 | *Entada Africana* | Mimosaceae | √ | √ | √ |
| 10 | *Ficus spp.* | Moraceae | √ | √ | X |
| 11 | *Gmelina arborea* | Lamiaceae | √ | √ | √ |
| 12 | *Khaya senegalensis* | Meliaceae | √ | √ | √ |
| 13 | *Mangifera indica* | Anacardiaceae | √ | √ | X |

| 14 | *Parkia biglobosa* | Mimosaceae | √ | X | √ |
|---|---|---|---|---|---|
| 15 | *Prosopsis Africana* | Mimosaceae | √ | X | √ |
| 16 | *Psidium guajava* | Myrtaceae | √ | √ | X |
| 17 | *Raphia sudanica* | Arecaceae | √ | √ | X |
| 18 | *Sterculia setigera* | Sterculiaceae | √ | √ | X |
| 19 | *Tamarindus indica* | Caesalpiniaceae | √ | √ | X |
| 20 | *Taminalia spp* | Combretaceae | √ | √ | X |
| 21 | *Vitaleria paradoxa* | Sapotaceae | √ | √ | √ |
| 22 | *Vitex doniana* | Verbernaceae | √ | √ | X |
| 23 | *Ximenia Americana* | Olacaceae | √ | X | √ |

*Source: Field Survey (2016) and Hashidu, 2015*

**Table 5.** Tree Species existence in Kanawa Forest Reserve

| S/N | SPECIES | FREQUENCY |
|---|---|---|
| 1 | *Acacia spp* | 5 |
| 2 | *Albizia labeck* | 1 |
| 3 | *Anogeisus leiocarpus* | 33 |
| 4 | *Azadirachta indica* | 32 |
| 5 | *Cassia siemea* | 30 |
| 6 | *Ceiba pentandra* | 2 |
| 7 | *Combrettum spp.* | 23 |
| 8 | *Detarium microcarpum* | 6 |
| 19 | *Entada Africana* | 1 |
| 10 | *Ficus spp.* | 8 |
| 11 | *Gmelina arborea* | 1 |
| 12 | *Khaya senegalensis* | 3 |
| 13 | *Mangifera indica* | 2 |
| 14 | *Psidium guajava* | 3 |
| 15 | *Raphia sudanica* | 30 |
| 16 | *Sterculia setigera* | 5 |
| 17 | *Tamarindus indica* | 2 |
| 18 | *Terminalia spp* | 2 |
| 19 | *Vitalleria paradoxum* | 3 |
| 20 | *Ximenia Americana* | 8 |
| | **Total** | **200** |

*Source: Field work (2016)*

**Table 6.** Species existence in Lembi Forest Reserve

| S/N | SPECIES | FREQUENCY |
|-----|---------|-----------|
| 1 | *Acasia sahel* | 3 |
| 2 | *Acasia siberiana* | 3 |
| 3 | *Anogeisus leocarpus* | 18 |
| 4 | *Azadirachta indica* | 10 |
| 5 | *Cassia siemea* | 6 |
| 6 | *Combrettum spp* | 19 |
| 7 | *Detarium microcarpum* | 21 |
| 8 | *Entada Africana* | 12 |
| 19 | *Gmelina arborea* | 5 |
| 10 | *Khaya senegalensis* | 15 |
| 11 | *Parkia biglobosa* | 20 |
| 12 | *Prosopsis Africana* | 10 |
| 13 | *Vitalleria paradoxum* | 6 |
| 14 | *Vitex doniana* | 5 |
| 15 | *Ximenia Americana* | 7 |
| | **Total** | **160** |

*Source: Field work (2016)*

**Table 7.** Species existence in Wawa Forest Reserve

| S/N | SPECIES | FREQUENCY |
|-----|---------|-----------|
| 1 | *Acasia sahel* | 3 |
| 2 | *Acasia siberiana* | 3 |
| 3 | *Anogeisus leocarpus* | 18 |
| 4 | *Azadirachta indica* | 10 |
| 5 | *Cassia siemea* | 6 |
| 6 | *Combrettum spp* | 19 |
| 7 | *Detarium microcarpum* | 21 |
| 8 | *Entada Africana* | 12 |
| 19 | *Gmelina arborea* | 5 |
| 10 | *Khaya senegalensis* | 15 |
| 11 | *Parkia biglobosa* | 20 |
| 12 | *Prosopsis Africana* | 10 |
| 13 | *Vitalleria paradoxum* | 6 |
| 14 | *Vitex doniana* | 5 |
| 15 | *Ximenia Americana* | 7 |
| 16 | *Termarindus indica* | |
| | **Total** | **200** |

*Source: Field work (2016)*

## 3.4. Soil Macro fauna in Wawa, Kanawa and Lembi Forest reserves

Table 8 shows the results of soil macro fauna in Wawa, Kanawa and Lembi Forest reserves. The results indicated that 32 species macro fauna were found in Wawa forest reserve compared to 18 and 9 macro fauna species found Kanawa in Lembi Forest reserve. This represents a 68% difference in species richness between Wawa forest reserve and Kanawa, and 50% difference between kanawa and Lembi forest reserves respectively. Also, the total abundance of macro fauna found in Wawa was 5 times higher/ richness than Kanawa Forest reserve and Kanawa forest reserve was 2.7 times higher than in the Lembi (de reserved) forest reserve. This is attributed to variations in sizes of these forest reserves and level of encroachment.

**Table 8.** Checklist of Soil Macro fauna in Wawa, Kanawa and Lembi Forest Reserves

| Scientific Name | Common Nme | Wawa forest | Kanawa forest | Lembi forest |
|---|---|---|---|---|
| *Oryctes boas* | Compost beetle | 89 | 55 | 25 |
| *Formica fusca* | Black ants | 145 | 100 | 150 |
| *Anisopia sp* | Bug nymph | 65 | 20 | 0 |
| *Lepidoptera sp* | Caterpiller | 87 | 20 | 0 |
| *Pachymerium ferrugineum* | Centipede | 188 | 105 | 20 |
| *Diplura* | Diplura | 32 | 10 | 0 |
| *Hyperriodrillus africana* | Earthworm | 198 | 155 | 50 |
| *Diptera* | Fly larva | 43 | 20 | 0 |
| *Lepidoptera* | Lepidoptera | 59 | 18 | 0 |
| *Archispiro streptus gigas* | Millipede | 204 | 155 | 5 |
| *Gryllotalpa Africana* | Mole crickets | 64 | 35 | 15 |
| *Arctia sp* | Moth larvae | 78 | 52 | 10 |
| *Acari* | Mites | 57 | 25 | 30 |
| *Armedillidium vulgare* | Pillbug | 24 | 5 | 0 |
| *Protura* | Protura | 36 | 10 | 0 |
| *Symphyta* | Sawfly larva | 10 | 5 | 0 |
| *Dorylus sp* | Soldier ants | 287 | 200 | 0 |
| *Hodotermes sp* | Termites | 432 | 300 | 150 |
| **Total Species** | | **2009** | **1250** | **455** |

*Source: Source: Field Survey (2016) and Hashidu 2015*

**Table 9.** Tree Specie Abundance and Diversity Kanawa Forest Reserve

| Species | Dist | Gith | Dbh | B.A | Freq (n) | Rel. cover | Rel. Freq | Rel. Dom | Rel. Dens | IVI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Acacia spp* | 2.7 | 79.248 | 25.222151 | 0.04997013 | 5 | 20 | 2.5 | 6.761857 | 1 | 3.420619 |
| *Albizia labbeck* | 0.9 | 86.36 | 27.485678 | 0.05934158 | 1 | 0 | 0.5 | 8.029984 | 0.2 | 2.909995 |
| *Anogeisus* | 2.848485 | 54.22545 | 17.258261 | 0.02339593 | 33 | 1056 | 16.5 | 3.16589 | 6.6 | 8.755297 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *leocarpus* | | | | | | | | | | |
| *Azadirachta indica* | 2.8875 | 49.25875 | 15.677514 | 0.01930637 | 32 | 992 | 16 | 2.612499 | 6.4 | 8.3375 |
| *Cassia siemea* | 2.93 | 60.874 | 19.374284 | 0.02948475 | 30 | 870 | 15 | 3.989818 | 6 | 8.329939 |
| *Ceiba pentandra* | 2 | 88.9 | 28.29408 | 0.06288359 | 2 | 2 | 1 | 8.509282 | 0.4 | 3.303094 |
| *Combrettum spp.* | 2.873913 | 59.20174 | 18.842056 | 0.02788706 | 23 | 506 | 11.5 | 3.773621 | 4.6 | 6.62454 |
| *Detarium microcarpum* | 2.516667 | 57.15 | 18.189052 | 0.02598761 | 6 | 30 | 3 | 3.516591 | 1.2 | 2.572197 |
| *Entada Africana* | 2.8 | 66.04 | 21.01846 | 0.03470148 | 1 | 0 | 0.5 | 4.695734 | 0.2 | 1.798578 |
| *Ficus spp.* | 2.7 | 104.6163 | 33.296069 | 0.08708275 | 8 | 56 | 4 | 11.78386 | 1.6 | 5.794621 |
| *Gmelina arborea* | 2.5 | 55.88 | 17.78485 | 0.02484544 | 1 | 0 | 0.5 | 3.362035 | 0.2 | 1.354012 |
| *Khaya senegalensis* | 3.166667 | 59.26667 | 18.86272 | 0.02794826 | 3 | 6 | 1.5 | 3.781903 | 0.6 | 1.960634 |
| *Mangifera indica* | 4.5 | 99.06 | 31.527689 | 0.07807832 | 2 | 2 | 1 | 10.5654 | 0.4 | 3.988467 |
| *Psidium guajava* | 3.566667 | 33.85667 | 10.775515 | 0.00912058 | 3 | 6 | 1.5 | 1.234178 | 0.6 | 1.111393 |
| *Raphia sudanica* | 2.636667 | 78.31733 | 24.92595 | 0.04880335 | 30 | 870 | 15 | 6.603971 | 6 | 9.201324 |
| *Sterculia setigera* | 2.84 | 54.356 | 17.299809 | 0.02350871 | 5 | 20 | 2.5 | 3.181152 | 1 | 2.227051 |
| *Tamarindus indica* | 2.95 | 63.5 | 20.210057 | 0.03208347 | 2 | 2 | 1 | 4.34147 | 0.4 | 1.913823 |
| *Taminalia spp* | 3.1 | 66.04 | 21.01846 | 0.03470148 | 2 | 2 | 1 | 4.695734 | 0.4 | 2.031911 |
| *Vitalleria paradoxum* | 3.066667 | 57.57333 | 18.323785 | 0.02637403 | 3 | 6 | 1.5 | 3.568882 | 0.6 | 1.889627 |
| *Ximenia Americana* | 3.2375 | 41.5925 | 13.237588 | 0.01376461 | 8 | 56 | 4 | 1.862599 | 1.6 | 2.487533 |
| | | | | 0.73926948 | 200 | 4502 | 100 | 100 | 40 | 100 |

## 3.5. Tree species abundance and diversity

Species diversity is one of the analytical tools applied in determining the degree of variability of species within a community or a region; it is a count of the different species present in an area, (Bello et al., 2013). Species richness is essentially a measure of the number of species in a defined sampling unit. And it is the basic component of diversity of any community, while species evenness refers to relative abundance or proportion of individuals among the species, (Bello et al., 2013). The distribution and abundance of different tree species over a landscape is what constitutes diversity in respect of tree species. Trees are the major structural component of forest ecosystems, and these forests are disappearing at an alarming rates owing to deforestation for extraction of timber and other forest produce or total conversion to other uses, (Abdullahi,2010).

**Table 10.** Tree Specie Abundance and Diversity Wawa Forest Reserve

| Species | Dist | Gith | Dbh | B.A | Dreq (n) | Rel.cover | Rel.Fre | Rel.Dom | Rel.Dens | IVI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Acasia sahel* | 3.566 | 59.26 | 18.8 | 0.02794 | 3 | 6 | 1.875 | 4.09198 | 0.00833 | 1.99177 |
| *Acasia siberiana* | 9.766 | 54.18 | 17.2 | 0.02336 | 3 | 6 | 1.875 | 3.42056 | 0.00833 | 1.76796 |
| *Anogeisus leocarpus* | 3.55555 | 54.46 | 17.3 | 0.0236 | 18 | 306 | 11.25 | 3.45629 | 0.05 | 6.91876 |
| *Azadirachta indica* | 3.26 | 94.996 | 30.2 | 0.0718 | 10 | 90 | 6. 25 | 10.5129 | 0.02777 | 5.5969 |
| *Cassia siemea* | 3.43333 | 40.64 | 12.9 | 0.01314 | 6 | 30 | 3.75 | 1.92406 | 0.01666 | 5.89691 |
| *Combrettum spp* | 3.95263 | 44.9178 | 14.2 | 0.01605 | 19 | 342 | 11.875 | 2.35045 | 0.05277 | 4.75941 |
| *Detarium microcarpum* | 3.40476 | 44.6314 | 14.2 | 0.01584 | 21 | 420 | 13.125 | 2.32057 | 0.05833 | 5.16796 |
| *Entada Africana* | 3.22727 | 56.8036 | 18 | 0.02567 | 12 | 132 | 7.5 | 3.75894 | 0.03333 | 6.76409 |
| *Gmelina arborea* | 4.06 | 186.944 | 59.4 | 0.27807 | 5 | 20 | 3.125 | 40.6541 | 0.01388 | 14.6173 |
| *Khaya senegalensis* | 3.84 | 96.1813 | 30.6 | 0.0736 | 15 | 210 | 9.375 | 10.7769 | 0.04166 | 6.73119 |
| *Parkia biglobosa* | 3.785 | 70.104 | 22.3 | 0.0391 | 20 | 380 | 12.5 | 5.7253 | 0.05555 | 8.09967 |
| *Prosopsis Africana* | 3.73 | 62.992 | 20 | 0.03157 | 10 | 90 | 6.25 | 4.62257 | 0.02777 | 5.63345 |
| *Vitalleria paradoxum* | 3.71666 | 58.8433 | 18.7 | 0.02755 | 6 | 30 | 3.75 | 4.03373 | 0.01666 | 8.60013 |
| *Vitex doniana* | 4.21666 | 34.29 | 10.9 | 0.00935 | 5 | 20 | 3.125 | 1.36977 | 0.01388 | 6.51288 |
| *Ximenia Americana* | 2.81428 | 29.0285 | 9.2 | 0.0067047 | 7 | 42 | 4.375 | 0.98166 | 0.01944 | 6.79203 |
|  | 60.3295 |  |  | 0.68340346 | 160 | 2124 | 100 | 100 | 0.44444 | 100 |

**D = 0.9165**

*Source: Field Survey (2016)*

## 3.6. Soil macro fauna abundance and diversity

The results have shown that despite the low diversity of soil macro fauna species that was a common feature in three existing Forest Reserve of Wawa, Kanawa and dereserved Lembi Forrest Reserve, the former had relatively greater diversity of soil macro fauna species than the others. The uneven distribution of the soil macro fauna species between these sites was also demonstrated by comparably marginal, albeit higher values of species diversity in the protected habitat. Many studies have found that the biodiversity of soil fauna increases as a result of existence of increased heterogeneity of microhabitat within the soil (Niklas and Janne, 2006). These microhabitats are sources of a variety of food materials in the soil which are necessary for sustaining higher diversity of the soil fauna species. However, heterogeneity of the soil habitat could give way to homogeneity if the soil is frequently disturbed (Nielsen et al., 2010) leading to massive destruction of other soil biota that need heterogeneous microhabitat to sustain high fauna diversity.

This argument is valid for species richness and is in line with species richness values of 23 with frequency 2009 for Wawa; 18 species with frequency of 1250 in Kanawa and 9 species recorded in Lembi, 9 with frequency of 455 (Abba et al., 2015).

## 4. Summary and conclusion

Our results revealed that the unsustainable exploitation of the studied forest reserves by the local communities has critically affected species evenness of the woody plants and population structure of the forests. This is evidenced by the very low density of not only plant species, but also macro fauna species in the forest reserves as a whole. Despite the escalating exploitation of the forests, diversity of woody plants in Wawa and Kanawa they still relatively high as compared to that of Lembi and other similar forest reserves. Despite the guarding and patrolling systems, these reserves have continued to be accessed illegally by the local people for wood gathering and for agriculture. Hence all the forest reserves studied were poorly populated. Lembi seems to be the worst, due to encroachment and de reservation. The findings of this study have shown that the study area is under serious threat by human activities, as shown in the results. Therefore, successful conservation programme in the study areas that would incorporate upon ecologically sound rural development method that lessens the pressures for the destruction of the remaining natural forest resources should be embarked upon.

## 5. Recommendations

From the results of this study, the following recommendations are made:

1- Kanawa Forest reserve should be closed for exploitation for at least ten years by the state Directorate of forestry, to enable the forest regenerate and for the soil to regain its fertility status.Government should enact laws that will restructure the forestry sub-sector in order to sustainably achieve the desired benefits of the forest resources.

2- Intensive ecological and livelihood study to track the trend of change in biodiversity status of our Forest Reserves, this would be used for monitoring of tree species diversity, macro fauna dynamics and local livelihoods, over period of time.

3- Creation of job and training opportunities for communities, within the Forest Reserves especially for the younger generation.

4- Encouraging the local communities, especially those in Lembi and Kanawa, to adopt the use of fuel efficient stoves (e.g 'Save 80'), to reduce pressure on the remaining forest resources.

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