

Original research paper

Tree Species Diversity and Population of Ikogosi Warm Spring and Arinta Waterfall Watersheds: Implication for Sustainable Ecotourism

ABSTRACT

An in-depth knowledge of the richness, diversity and species composition of plant community is vital for providing information for planning and sustainable utilization. This study assesses the diversity and population of tree species of Ikogosi warm spring and Arinta waterfalls watersheds in Ekiti State. Direct observation and vegetation assessment were methods used for data collection in this study. Two hectares (ha) of land were measured and divided into four plots of 50 m by 50 m in each study sites. Two plots were diagonally selected within each hectare. All living trees of basal diameter ≥ 10 cm were identified and classified into families. Shannon Weiner and species evenness indices were used to assess and compare tree species diversity and abundance. Sorenson's coefficient was used to compare sites for overlapping of similarity. The results revealed that Ikogosi warm spring centre is well equipped in term of infrastructural facilities than Arinta waterfall centre. Seventy eight (78) species and 25 families were recorded in both watersheds with family Malvaceae having the highest species density (15). *Malacantha alnifolia* (5) and *Voacanga africana* (5) were the species most frequently encountered. Species diversity indices shows that Shannon-Wiener index are 4.11 and 3.48 and species evenness index are 0.92 and 0.90 in Arinta and Ikogosi respectively while Sorenson's coefficient is 0.50. Family diversity indices shows that Shannon-Wiener index are 2.64 and 2.65 and family evenness index are 0.09 and 0.08 in Arinta and Ikogosi respectively while Sorenson's coefficient is 0.71. The study recommend that environmental impact assessment should be carried out especially in Arinta waterfall before any alteration is made at the watershed in the

name of infrastructural development.

Keywords: *Species diversity, Ikogosi warm spring, Arinta waterfall, Sustainable ecotourism, Ekiti State.*

1. INTRODUCTION

Tree as a major component of forest is an important natural resource capable of producing diverse tangible products such as sawn wood, fuel wood and fruits. It also provides services such as game viewing, recreation, tourism opportunities for the people and eco-protection through conservation. It is also a means of income generation for government, providing employment opportunities for people as well as provision of other mans' essential needs [1]. Forest trees help in checking Global warming by using up carbon IV oxide in photosynthetic process. They form an effective sink for the CO₂ produced as a result of animal respiration, burning of fossil fuel and other natural and human induced phenomena.

Recent discoveries has vividly revealed that most of our protected areas are of sub-climax ecosystems for which management is essential if the desired characteristics of the ecosystem are to be maintained: Even in those regions of the world where protected areas contain quite natural self-regenerating climax ecosystems, there is still sometimes a need for management in order to enhance goods and services derived from those forests. Biodiversity is essential for human survival, economic well-being and ecosystem function and stability [2].Habitat destruction, over exploitation; pollution and homogenous species introduction have been identified as major causes of biodiversity loss [3]. The disturbances created by these factors determine forest dynamics and tree diversity of an area [4].

Altitude is a determinant in plant distribution and biodiversity patterns [5]. An in-depth knowledge of the richness, diversity and species composition of plant community formation is vital for planning and conservation actions that can reduce the environmental impact of development on an ecosystem [6]. Measures of species diversity play a central role in

ecology and conservation biology. The diversity of tree species is fundamental to total forest biodiversity, because trees provide resources and habitat for almost all other forest species. Before the development of any natural resource into an ecotourism sites, it is necessary to know much about the vegetation and other potentials embedded in such an area as it will help to identify measures to be used for the conservation of the potentials of such area.

Forest in Ikogosi warm spring is valued for its high biodiversity, ecosystem, historical and ecotourism importance [7].The potential of Ikogosi warm spring and Arinta waterfall watershed in terms of environmental, and socio economic benefits cannot be over emphasized. However, the effort of the state government to upgrade the ecotourism status of the study area has led to the loss of endangered woody species and non-timber forest products thereby causing in-balance in the ecosystem of the site. Although, the development of infrastructures is inevitable in as much as aesthetic values of the place is to be maximally and efficiently utilized but measures should be put in place to ensure that the native vegetation species are conserved for posterity. Therefore, to manage these forests for ecotourism purpose on a sustainable level, there is the need to identify tree species present, land use practices to which the site is subjected to, and the conservation measure been put in place by the government at the sites. This will we help the stake holders and government to properly manage the forest on a sustainable level to improve its ecotourism potential.

2. MATERIALS AND METHODS

2.1. Study Area

Ikogosi-Ekiti and Ipole-Iloro-Ekiti are located in Ekiti West Local Government, Ekiti State, Nigeria. The two towns are about 5km distance apart and are situated between lofty; step sided and heavily wooded, north-south trending hills. They lies on an area underlain by metamorphic rock with undulating landscape, consisting of old plains broken by step-sided out-crops that occur in groups of ridge [7]. Ikogosi-Ekiti ($7^{\circ} 35^1 0''$ N., $4^{\circ} 92^1 0''$ E.) and Ipole-Iloro-Ekiti ($7^{\circ} 40^1 0''$ N. $4^{\circ} 59^1 0''$ E.) have tropical climate of West Africa monsoonal type with

two distinct seasons. These are the rainy season (April-October) and the dry season (November-March). The annual rainfall ranged from 1,200 mm to 1,500 mm. Temperature ranges between 21°C and 34°C with high humidity. The South Westerly wind and the North-East trade wind blow in the rainy season and dry (Harmattan) season respectively. The vegetation is of tropical rain forest.

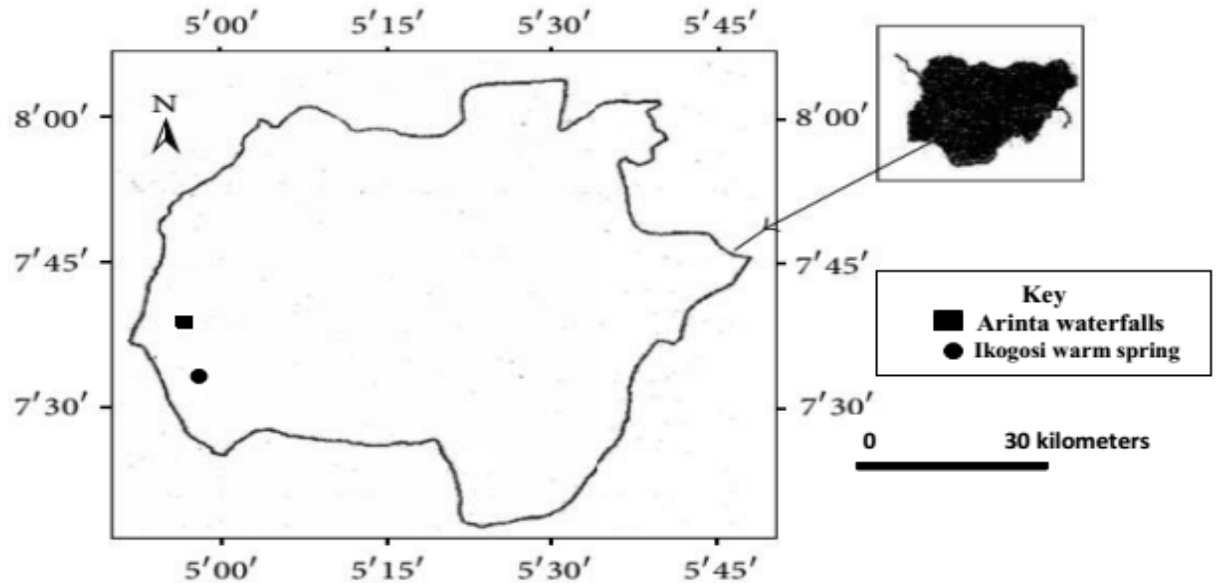


Figure 1: Map of Ekiti State showing the location of the study areas

2.2. Method of data collection

Direct observation and vegetation assessment are the two methods used for data collection in this study. Vegetation assessment of the watersheds was done by enumeration method as described by [8]. Two hectares (ha) of land (one close to places where visitors could easily assess and one in the undisturbed area of the watershed) were measured and divided into four plots of 50 m by 50 m in each of the study sites. Two plots were diagonally selected within each hectare to make a total of 8 plots in the two study sites. Five (5) transects were laid at an interval of 10 m in the selected plots. Living trees of basal diameter ≥ 10 cm were identified with the help of a taxonomist using standard key. Where the tree's botanical name was not known it was identified by its commercial or local name and later translated to

correct botanical names using standard key [9]. The height of each tree was measured to the nearest meter with Spiegel Relaskop.

2.3 Data analyses

Diversity Index

Species diversity index (H) was computed using the Shannon-Wiener diversity index equation.

$$H^1 = - \sum_{i=1}^s P_i \ln (P_i) \dots\dots\dots \text{(Equation 1)}$$

Where: H' = Shannon-Wiener diversity index; S = Total number of species in the site; Pi= proportion of S made up of the ith species; ln = natural logarithm.

Species Evenness

Species evenness in each community was determined using Shannon's equitability (E_H), which was obtained using equation (S); [10].

$$E_H = \frac{H^1}{H_{max}} = \frac{\sum_{i=1}^s P_i \ln (P_i)}{\ln (S)} \dots\dots\dots \text{(Equation 2)}$$

Sorenson's coefficient

Diversity indices of the frequency of Tree species diversity in the two sites

$$(\beta) = \frac{C}{S_1 + S_2 - C} \dots\dots\dots \text{(Equation 3)}$$

Where C = Total number of species in the two study areas; S1 = Total number of species in Ikogosi warm spring; S2 = Total number of species in Arinta waterfall.

All analysis were carried out using the computer model PAST version 3. Tree species were classified into families. Trees within strata of each forest were classified into three layers using method of [11].

3. RESULTS

3.1 Infrastructural facilities at the ecotourism centres and the host communities

The result in table 1 shows that Ikogosi warm spring centre is well equipped with the presence of recreational facilities such as hotel, swimming pool, relaxation sport, fitness shop and multipurpose hall than the Arinta waterfall centre.

Table 1: Facilities at the ecotourism centres and the host communities

| Infrastructural facilities | Ikogosi-Ekiti | Ipole-Iloro-Ekiti |
|----------------------------|---------------|-------------------|
| | Status | Status |
| Hotel and restaurants | √ | √ |
| Federal/State chalets | √ | X |
| Relaxation sport | √ | √ |
| Swimming pool | √ | X |
| Beauty centre | √ | X |
| Fitness Shop | √ | X |
| School | √ | √ |
| Health centre | √ | √ |
| Arts and crafts shops | √ | X |
| Electricity | √ | √ |
| Shopping mall | √ | X |
| Car parking facility | √ | √ |
| Staff quarters | √ | X |
| Worship centre | √ | √ |
| Market | √ | √ |
| Road | √ | √ |
| Concrete walkway | √ | X |
| Multi-purpose hall | √ | X |
| Water bottling plant | √ | X |

√ = present

x = absent



Plate1: A building showing relaxation centre with walk way at Ikogosi warm spring



Plate 2: Picture showing the source of warm spring at Ikogosi



Plate 3: Arinta waterfall



Plate 4: Vegetation in one of the sampled plot in Arinta waterfall watershed

3.2 Tree species composition in the study area

Table 2 shows that 78 species were recorded in both Ikogosi warm spring and Arinta waterfalls. The result revealed that the vegetation in Arinta waterfall has higher number of species (66) than that of Ikogosi warm spring with 36 species. The result also shows that the vegetation in Arinta waterfalls has higher number of individual tree (158) than the vegetation in Ikogosi warm spring which had 72 individual tree species in the sampled plots. The result revealed that *Malacantha alnifolia* (5) and *Voacanga africana* (5) are the species frequently enchanter in the study area while tree with the highest diameter at breast height (dbh) is *Delonix regia* (3.8 cm) and tree species with the highest height is *Ricinodendron heudelotii* (12.88 m). In Ikogosi warm spring, *Anthocleista vogelii*, *Antiaris africana*, *Delonix regia* are the most common species with frequency of 4 each while tree species with highest dbh is *Anthocleista vogelii* (1.64 cm) and tree species with the highest height is *Brachystegia eurycoma* (12.72m). In Arinta waterfall, *Malacantha alnifolia* and *Voacanga Africana* are the most common species with frequency of (5 each) while tree species with the highest dbh is *Delonix regia* (3.8 cm) and tree species with the highest height is *Ricinodendron heudelotii* (12.88m).

Table 2: Tree species composition of Ikogosi warm spring and Arinta waterfall watershed

| S/N | Species | Families | Ikogosi warm spring | | | Arinta waterfall | | |
|-----|------------------------------|---------------|---------------------|------|--------|------------------|------|--------|
| | | | Freq. | Dbh | Height | Freq | Dbh | Height |
| 1 | <i>Afzelia Africana</i> | Fabaceae | 3 | 0.63 | 9.15 | 0 | 0 | 0 |
| 2 | <i>Albizia adianthifolia</i> | Fabaceae | 3 | 0.54 | 12 | 0 | 0 | 0 |
| 3 | <i>Alchornea cordifolia</i> | Fabaceae | 0 | 0 | 0 | 2 | 0.85 | 9.12 |
| 4 | <i>Alstonia booneii</i> | Euphorbiaceae | 2 | 0.59 | 8.32 | 2 | 0.76 | 10.56 |
| 5 | <i>Amphimas pterocpoides</i> | Apocynaceae | 3 | 0.69 | 8.26 | 0 | 0 | 0 |

| | | | | | | | | |
|----|------------------------------------|---------------|---|------|-------|---|------|-------|
| 6 | <i>Aningeria robusta</i> | Fabaceae | 0 | 0 | 0 | 1 | 0.54 | 7.42 |
| 7 | <i>Anthocleista vogelii</i> | Sapotaceae | 4 | 1.64 | 11.52 | 0 | 0 | 0 |
| 8 | <i>Anthonotha macrophylla</i> | Loganiaceae | 1 | 0.61 | 9.2 | 0 | 0 | 0 |
| 9 | <i>Antiaris africana</i> | Moraceae | 4 | 0.47 | 9.58 | 3 | 3.5 | 12.52 |
| 10 | <i>Artocarpus altilis</i> | Moraceae | 0 | 0 | 0 | 2 | 3.5 | 12.52 |
| 11 | <i>Bombax buonopozense</i> | Malvaceae | 1 | 0.64 | 9.92 | 3 | 3.5 | 12.52 |
| 12 | <i>Brachystegia evrycoma</i> | Moraceae | 3 | 0.67 | 12.72 | 2 | 1.74 | 11.28 |
| 13 | <i>Bridelia atroviridis</i> | Euphorbiaceae | 1 | 0.47 | 9.36 | 0 | 0 | 0 |
| 14 | <i>Canarium schweinfurthii</i> | Burseraceae | 2 | 0.92 | 10.6 | 0 | 0 | 0 |
| 15 | <i>Ceiba pentandra</i> | Malvaceae | 2 | 0.67 | 10.8 | 0 | 0 | 0 |
| 16 | <i>Chrysophyllum albidum</i> | Sapotaceae | 1 | 0.59 | 8.77 | 1 | 0.64 | 9.92 |
| 17 | <i>Cleistopholis patens</i> | Annonaceae | 1 | 0.59 | 9.15 | 3 | 0.72 | 8.48 |
| 18 | <i>Cola hispida</i> | Malvaceae | 0 | 0 | 0 | 2 | 1.68 | 10.68 |
| 19 | <i>Cola millenii</i> | Malvaceae | 0 | 0 | 0 | 1 | 1.4 | 11.84 |
| 20 | <i>Cola nitida</i> | Malvaceae | 0 | 0 | 0 | 2 | 1.74 | 11.72 |
| 21 | <i>Daniellia ogea</i> | Fabaceae | 0 | 0 | 0 | 3 | 0.87 | 9.15 |
| 22 | <i>Delonix regia</i> | Fabaceae | 4 | 0.47 | 8.38 | 2 | 3.8 | 11.48 |
| 23 | <i>Dracaena arborea</i> | Asparagaceae | 1 | 0.47 | 8.38 | 0 | 0 | 0 |
| 24 | <i>Elaeis guineensis</i> | Arecaceae | 2 | 0.67 | 11.2 | 0 | 0 | 0 |
| 25 | <i>Enantia chlorantha</i> | Annonaceae | 0 | 0 | 0 | 1 | 1.4 | 10.88 |
| 26 | <i>Entandrophragma cylindricum</i> | Meliaceae | 1 | 0.62 | 8.72 | 3 | 0.54 | 10.5 |
| 27 | <i>Ficus exasperate</i> | Moraceae | 0 | 0 | 0 | 2 | 0.54 | 9.54 |
| 28 | <i>Funtumia elastic</i> | Apocynaceae | 0 | 0 | 0 | 2 | 1.37 | 10.44 |

| | | | | | | | | |
|----|-----------------------------------|---------------|---|------|------|---|------|-------|
| 29 | <i>Gilbertiodendron dewevrei</i> | Fabaceae | 2 | 0.78 | 9.52 | 0 | 0 | 0 |
| 30 | <i>Gmelina arborea</i> | Labiatae | 0 | 0 | 0 | 2 | 0.67 | 8.7 |
| 31 | <i>Harungana madagascariensis</i> | Hypericaceae | 1 | 0.43 | 9.7 | 0 | 0 | 0 |
| 32 | <i>Hollarhena floribunda</i> | Apocynaceae | 0 | 0 | 0 | 1 | 0.85 | 12.68 |
| 33 | <i>Hunteria umbellata</i> | Apocynaceae | 0 | 0 | 0 | 3 | 1.64 | 10.36 |
| 34 | <i>Macaranga spinosa</i> | Euphorbiaceae | 2 | 0.67 | 9.88 | 3 | 0.72 | 9.4 |
| 35 | <i>Malacantha alnifolia</i> | Sapotaceae | 0 | 0 | 0 | 5 | 0.75 | 9.48 |
| 36 | <i>Mallotus subulatus</i> | Euphorbiaceae | 0 | 0 | 0 | 3 | 0.7 | 8.96 |
| 37 | <i>Mangifera indica</i> | Anacardiaceae | 1 | 0.78 | 9.58 | 2 | 0.84 | 9.98 |
| 38 | <i>Milicia excels</i> | Moraceae | 0 | 0 | 0 | 2 | 0.56 | 9.12 |
| 39 | <i>Milicia regia</i> | Moraceae | 1 | 0.67 | 8.64 | 4 | 0.92 | 10.85 |
| 40 | <i>Mitragyna stipulosa</i> | Rubiaceae | 2 | 0.51 | 9.68 | 1 | 0.68 | 9.12 |
| 41 | <i>Monodora myristica</i> | Annonaceae | 2 | 0.69 | 9.68 | 2 | 0.54 | 7.52 |
| 42 | <i>Monodora tenuifolia</i> | Annonaceae | 2 | 0.76 | 9.2 | 2 | 2.98 | 12.32 |
| 43 | <i>Musanga cecropioides</i> | Urticaceae | 2 | 0.68 | 10.4 | 2 | 0.74 | 9.38 |
| 44 | <i>Myrianthus arboreus</i> | Moraceae | 1 | 0.54 | 10.8 | 1 | 0.76 | 9.84 |
| 45 | <i>Nauclea diderrichii</i> | Rubiaceae | 0 | 0 | 0 | 1 | 0.62 | 9.28 |
| 46 | <i>Nauclea latifolia</i> | Rubiaceae | 0 | 0 | 0 | 2 | 0.78 | 8.16 |
| 47 | <i>Nesogordonia papaverifera</i> | Malvaceae | 2 | 0.78 | 8.16 | 2 | 1.04 | 9.86 |
| 48 | <i>Newtonia buchanani</i> | Fabaceae | 0 | 0 | 0 | 2 | 0.68 | 8.26 |
| 49 | <i>Nothospondias staultii</i> | Anacardiaceae | 1 | 0.53 | 8.7 | 2 | 0.52 | 9.84 |
| 50 | <i>Ochroma lagopus</i> | Malvaceae | 1 | 0.57 | 11.4 | 3 | 2.45 | 9.88 |
| 51 | <i>Pentaclethra</i> | Fabaceae | 0 | 0 | 0 | 4 | 0.78 | 9.98 |

| | | | | | | | | | |
|-----------|------------------------------|---------------|---|------|-------|---|------|-------|--|
| | <i>macrophylla</i> | | | | | | | | |
| 52 | <i>Piptadeniastrum</i> | Fabaceae | 0 | 0 | 0 | 3 | 0.75 | 9.48 | |
| | <i>africanum</i> | | | | | | | | |
| 53 | <i>Pseudospondia</i> | Anacardiaceae | 3 | 0.74 | 10.88 | 1 | 0.64 | 8.48 | |
| | <i>microcarpa</i> | | | | | | | | |
| 54 | <i>Pseudospondias</i> | Anacardiaceae | 3 | 0.57 | 9.48 | 3 | 0.94 | 10.85 | |
| | <i>mombin</i> | | | | | | | | |
| 55 | <i>Psydrax arnoldiana</i> | Rubiaceae | 3 | 0.92 | 10.88 | 4 | 0.76 | 8.26 | |
| 56 | <i>Psydrax subcordata</i> | Rubiaceae | 2 | 0.7 | 9.88 | 3 | 0.62 | 8.16 | |
| 57 | <i>Pterocarpus osun</i> | Leguminosae | 2 | 0.57 | 9.98 | 2 | 0.64 | 8.15 | |
| 58 | <i>Pterygota macrocarpa</i> | Malvaceae | 0 | 0 | 0 | 3 | 1.04 | 10.98 | |
| 59 | <i>Pycnanthus angolensis</i> | Myristicaceae | 0 | 0 | 0 | 2 | 0.76 | 8.26 | |
| 60 | <i>Raphia hookeri</i> | Arecaceae | 0 | 0 | 0 | 3 | 0.62 | 8.16 | |
| 61 | <i>Rauvolfia vomitoria</i> | Apocynaceae | 0 | 0 | 0 | 1 | 1.5 | 8.96 | |
| 62 | <i>Rhodognaphalon</i> | Bombacaceae | 0 | 0 | 0 | 3 | 1.19 | 9.98 | |
| | <i>brevicuspe</i> | | | | | | | | |
| 63 | <i>Ricinodendron</i> | Euphorbiaceae | 0 | 0 | 0 | 1 | 0.98 | 12.88 | |
| | <i>heudelotii</i> | | | | | | | | |
| 64 | <i>Rothimannia hispida</i> | Rubiaceae | 0 | 0 | 0 | 2 | 0.62 | 9.28 | |
| 65 | <i>Senna siamea</i> | Fabaceae | 0 | 0 | 0 | 3 | 0.61 | 8.34 | |
| 66 | <i>Spondias mombin</i> | Anacardiaceae | 0 | 0 | 0 | 3 | 0.52 | 8.55 | |
| 67 | <i>Stercospermum</i> | Bignoniaceae | 0 | 0 | 0 | 2 | 0.78 | 9.44 | |
| | <i>acuminatissimum</i> | | | | | | | | |
| 68 | <i>Sterculia rhinopetala</i> | Malvaceae | 0 | 0 | 0 | 4 | 1.32 | 11.68 | |
| 69 | <i>Sterculia tragacantha</i> | Malvaceae | 0 | 0 | 0 | 3 | 0.78 | 9.88 | |
| 70 | <i>Tabernamontana</i> | Apocynaceae | 0 | 0 | 0 | 3 | 0.95 | 8.8 | |

| <i>pachysiphon</i> | | | | | | | | |
|--------------------|---------------------------------|--------------|----|-------|-------|-----|------|-------|
| 71 | <i>Tectona grandis</i> | Verbenaceae | 0 | 0 | 0 | 2 | 0.48 | 8.16 |
| 72 | <i>Terminalia ivorensis</i> | Combretaceae | 0 | 0 | 0 | 3 | 1.17 | 11.42 |
| 73 | <i>Terminalia superba</i> | Combretaceae | 0 | 0 | 0 | 2 | 0.64 | 8.64 |
| 74 | <i>Theobroma cacao</i> | Malvaceae | 0 | 0 | 0 | 3 | 0.72 | 9.52 |
| 75 | <i>Triplochiton scleroxylon</i> | Malvaceae | 0 | 0 | 0 | 1 | 0.74 | 9.36 |
| 76 | <i>Uvariastrum</i> | Annonaceae | 0 | 0 | 0 | 4 | 3.57 | 11.88 |
| <i>pierreanum</i> | | | | | | | | |
| 77 | <i>Voacanga Africana</i> | Apocynaceae | 0 | 0 | 0 | 5 | 0.92 | 8.64 |
| 78 | <i>Zanthoxylum gillettii</i> | Rutaceae | 0 | 0 | 0 | 3 | 0.41 | 8.64 |
| Total | | | 72 | 23.74 | 342.2 | 158 | 73.9 | 648.3 |
| | | | | | 1 | | 8 | 7 |

3.3 Richness of major plant family in the study areas

Distribution of the tree in the two ecotourism centres by families is presented in table 3. The result revealed that a total of twenty-five (25) families of tree were identified in the two study areas with 17 and 20 families in Ikogosi warm spring and Arinta waterfall respectively. The result revealed that family Malvaceae has the highest species density (15) in the study area. This was followed by the family Fabaceae (12), Anacardiaceae and Myristicaceae with species density of nine (9) each. At Ikogosi warm spring, the families with highest no of species density include Anacardiaceae, Fabaceae, Malvaceae and Myristicaceae with density of four (4) each. While in Arinta waterfall, the family Malvaceae has the highest species density of 11.

Table 3: Contribution of family to tree species density in the study area

| SN | Families | Ikogosi warm spring | Arinta waterfall | Total Density |
|----|---------------|---------------------|------------------|---------------|
| 1 | Anacardiaceae | 4 | 5 | 9 |
| 2 | Annonaceae | 3 | 5 | 8 |
| 3 | Apocynaceae | 1 | 6 | 5 |
| 4 | Arecaceae | 1 | 1 | 2 |

| | | | | |
|----|---------------|----|----|-----|
| 5 | Asparagaceae | 1 | 0 | 1 |
| 6 | Bignoniaceae | 0 | 1 | 1 |
| 7 | Burseraceae | 1 | 0 | 1 |
| 8 | Bombacaceae | 0 | 1 | 1 |
| 9 | Combretaceae | 0 | 2 | 2 |
| 10 | Euphorbiaceae | 3 | 4 | 7 |
| 11 | Fabaceae | 4 | 8 | 12 |
| 12 | Hypericaceae | 1 | 0 | 1 |
| 13 | Labiatae | 0 | 1 | 1 |
| 14 | Leguminosae | 1 | 1 | 2 |
| 15 | Loganiaceae | 1 | 0 | 1 |
| 16 | Malvaceae | 4 | 11 | 15 |
| 17 | Meliaceae | 1 | 1 | 2 |
| 18 | Moraceae | 0 | 7 | 7 |
| 19 | Myristicaceae | 4 | 1 | 5 |
| 20 | Rubiaceae | 3 | 6 | 9 |
| 21 | Rutaceae | 0 | 1 | 1 |
| 22 | Sapotaceae | 2 | 2 | 4 |
| 24 | Urticaceae | 1 | 1 | 2 |
| 25 | Verbenaceae | 0 | 1 | 1 |
| | Total | 36 | 66 | 102 |

3.4 Diversity indices of trees in the Study Sites

Results on species diversity indices of Ikogosi warm spring and Arinta waterfall watersheds are presented in table 4. The result revealed that Shannon-Wiener diversity index of Arinta waterfall is 4.11 while that of Ikogosi warm spring is 3.48. Result on species evenness of Arinta waterfall is 0.92 while that of Ikogosi warm spring is 0.90. Sorenson's coefficient (SC) of similarity between the species of plant in the study areas shows a value 0.5. Also Result on diversity indices of tree families revealed that Shannon-Wiener diversity index is 2.65 in Ikogosi warm spring while that of Arinta waterfall is 2.64 while family evenness in Arinta waterfall and Ikogosi warm spring are 0.70 and 0.83 respectively. Sorenson's coefficient (SC) of similarity between the families of plant in the study areas shows a value 0.71.

Table 4: Diversity indices of tree species in the study areas

| Variables | Species | | Family | |
|----------------|---------|--------|---------|--------|
| | Ikogosi | Arinta | Ikogosi | Arinta |
| Shannon_H | 3.48 | 4.11 | 2.65 | 2.64 |
| Evenness_e^H/S | 0.90 | 0.92 | 0.83 | 0.70 |

3.5 Vegetation structure and forest characteristics of the study areas

Table 5 presents results on the vegetation structure and forest characteristics of the study area. The result reveals that most of the tree species enumerated around the built-up/recreational area of the study locations fall within the lower stratum of the forest structure. The middle layer category in Arinta waterfall has six (6) tree species while vegetation in Ikogosi has one (1). The result on lower stratum revealed more trees in Arinta waterfall (60) while that of Ikogosi warm spring has 35. The mean dbh of tree species in the lower stratum in Arinta waterfall is higher (97.78 cm) than that of Ikogosi warm spring (65.91 cm). Also, the mean height of tree species in the lower stratum in Arinta waterfall and Ikogosi warm spring are 9.55 m and 9.41m respectively.

Table 5: Vegetation structure and forest characteristics of the study areas

| Variables | Ikogosi warm spring | Arinta waterfall |
|---|---------------------|------------------|
| Upper layer trees (≥ 22 m) | 0 | 0 |
| Mean DBH (cm) | 0 | 0 |
| Mean Height (m) | 0 | 0 |
| Middle layer trees (≥ 13 m ≤ 21 m) | 1 | 6 |
| Mean DBH (cm) | 67 | 255.2 |
| Mean Height (m) | 12.72 | 12.57 |
| lower stratum trees (≤ 12 m) | 35 | 60 |
| Mean DBH (cm) | 65.91 | 97.78 |
| Mean Height (m) | 9.41 | 9.55 |

4.0 DISCUSSION

The observed floristic richness of the vegetation in the two ecotourism sites revealed the true characteristics of a tropical forest whereby an area of land as small as one hectare could consist of so many species. This observation corroborates the report by [12] and [13] who in separate studies recorded 67 plant species at Okomu National Park and 57 tree species at International Institute of Tropical Agriculture (IITA) forest reserve respectively. The generally low number of tree species recorded at Ikogosi warm spring compared to that of Arinta waterfall in this study could be attributed to heavy presence of recreational/infrastructural facilities at Ikogosi warm spring (table 1). The upgrading of Ikogosi warm spring to a resort centre of international standard by the State Government in the recent times with building of more infrastructural and other recreational facilities calls for clearance of more land and consequent removal of trees in the build-up area. This assertion is in consonance with the findings of [14]. on the negative impacts of recreation and tourism on plants communities in protected areas in Australia.

Biodiversity indices on plant species in the study area revealed that the general arrangement of plants across the two studied sites appears to be similar (Tables 2 and 3) with *Malacantha alnifolia*, *Voacanga africana* (5 each) and *Anthocleista vogelii*, *Antiaris africana*, *Delonix regia* (4 each) been the most common species in the study area while Malvaceae, Fabaceae, Anacardiaceae, Rubiaceae, Moraceae and Euphorbiaceae are the dominant family. This observation is an indication that the watersheds consist of basically indigenous hardwood species which signifies little human interference. This submission is in consonance with the report by [15] on tree species composition of Akure Strict Nature Reserve.

The similarities observed in species and family diversity of the plant communities as well as the vegetation structure in the two watersheds as depicted by result in (Tables 4 and 5) is

similar to what obtained in other forest reserves in southern Nigeria. This assertion is in agreement with the report of [16] that vegetation structures in south western Nigeria are similar in architecture. The observed homogeneity of the vegetation of the study sites in terms of structure did not permit different habitat structure and this could have negative effect on the diversity and distribution of wildlife species in the study area. This assertion corroborates the submission of [7, 8] that Ikogosi warm spring watershed is of low ecotourism value in term of wildlife population compare to other protected area of Southwest Nigeria with diverse ecological niche. Also the low number of wildlife population observed in the study sites (except for few primates) especially in Ikogosi warm spring could be due to noise from heavy traffic of tourist to the centre.

5. CONCLUSION

Findings from this study have revealed that the vegetation of the study area is a repository of many tree species with high ecotourism potential. The study also revealed that the vegetation across the two study sites is similar both in tree species diversity and ecosystem structure. Consequence upon these findings it is recommended that enrichment planting of both indigenous and exotic plant species of biological importance should be carried out especially in less sensitive area of the warm spring in order for the watershed to retain its flora richness. Government should as a matter of necessity construct a mini zoological garden at Ikogosi warm spring to boost its status as ecotourism site. Also environmental impact assessment should be carried out particularly in Arinta waterfalls site before any alteration is made to the flora and fauna of the study site in the name of infrastructural development.

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