Original research paper

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

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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 of tree species of Ikogosi warm spring and Arinta waterfalls watersheds in Ekiti State, Nigeria. Direct observation and vegetation assessment were used for data collection in two hectares (ha) of land divided into four plots of 50 m by 50 m in each of the two study sites (Ikogosi warm spring and Arinta waterfall). Two plots were diagonally selected within each hectare. All living trees of basal diameter ≥10 cm were identified and classified into families. Shannon-Weiner diversity index, species evenness, relative density (RD), relative dominance (RD_0) and importance value index (IVI) 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 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 revealed vegetation with very high tree species diversity and abundance in the two study sites. Species evenness value revealed even distribution in Arinta waterfall than in Ikogosi warm spring. Diameter and height distribution of trees at the two watersheds indicates a forest structure that is immature and still expanding. *Anthocleista vogelii,* has the highest value of RD_0 (15.63) and IVI (10.6) respectively. The study revealed that some species such as *Anthonotha macrophylla, Aningeria robusta, Bridelia atroviridis, among others* are threatened and endangered.

Consequently, it was recommended that management strategies should be put in place to improve status of the watersheds while conservation efforts should be stepped up for species with rarity index value to prevent them from going into extinction.

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

1. INTRODUCTION

Tree as a major component of forest is an important natural resource capable of producing diverse tangible products and also provides services such as game viewing, recreation and tourism opportunities. It is a means of income generation for government and providing employment opportunities for people [1]. Forest trees help in checking Global warming by acting an effective sink for the $CO_{2.}$ 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 [2]. 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 [2].

Biodiversity refers to the variability among living organisms from all sources including, among other things, terrestrial and aquatic ecosystems. This variability includes within species and between species. Biodiversity is essential for human survival, economic well-being and ecosystem function and stability [3]. Habitat destruction, over exploitation; pollution and species introduction have been identified as major causes of biodiversity loss [4]. The disturbances created by these factors determine forest dynamics and tree diversity of an area [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]. The diversity of tree species is fundamental to total forest biodiversity, because trees provide resources and habitat for almost all other forest species. In natural resources management operations, inventories of biodiversity are used to determine the nature and distribution of biodiversity of an area being managed. This also determined the measure to be put in place in the management of such area to enable the resources to fulfill their potentials [7]

A viable ecotourism centre helps in community development by providing the alternative and sustainable source of livelihood to local community [8]. It has contributed to conservation of biodiversity; promotes small and medium tourism enterprises; stresses local participation, ownership and business opportunities, particularly for rural people; and above all includes the learning experiences [9]. Ecotourism centre has help in involving local community for conservation of the ecology and biodiversity which in turn provides the economic incentives to the local community; sustains the health and well-being of local people; involves responsible action on the part of tourist and the tourism industry [10].

Ecotourism being a nature based tourism which takes into account the natural ecological attraction, their conservation and development has attracted increasing attention in recent years, not only as an alternative to mass tourism, but also as a means of economic development and environmental conservation [11, 12]. The aim of an ecosystem manager is to protect the environment, making it profitable to the community people by generating revenue, educating and serving the pleasure of tourists. In situ conservation is a veritable tool for the preservation of genetic resources currently decreasing at an alarming rate [13]. 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 in Nigeria is valued for its high biodiversity, ecosystem and ecotourism importance [14].Similarly the Arinta waterfall is also well-known for its ecotourism value [15]. 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 [16]. 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 and species diversity, land use practices to which the site is subjected to, and the conservation measure been put in place by 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 warm spring and Arinta waterfall watersheds 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 underlain by metamorphic rock with undulating landscape [7]. Ikogosi warm spring (7^{o} 35' 0" N., 4^{o} 92' 0" E.) and Arinta waterfall (7^{o} 40' 0" N.4^{o} 59' 0" E.) sites have tropical climate of West Africa monsoonal type with two distinct rainy (April-October) and the dry (November-March) season. The annual rainfall ranged from 1,200 mm to 1,500 mm and temperature ranges between 21^{o}C and 34^{o}C with high humidity. The vegetation is of tropical rain forest. [17] Adebayo 1993

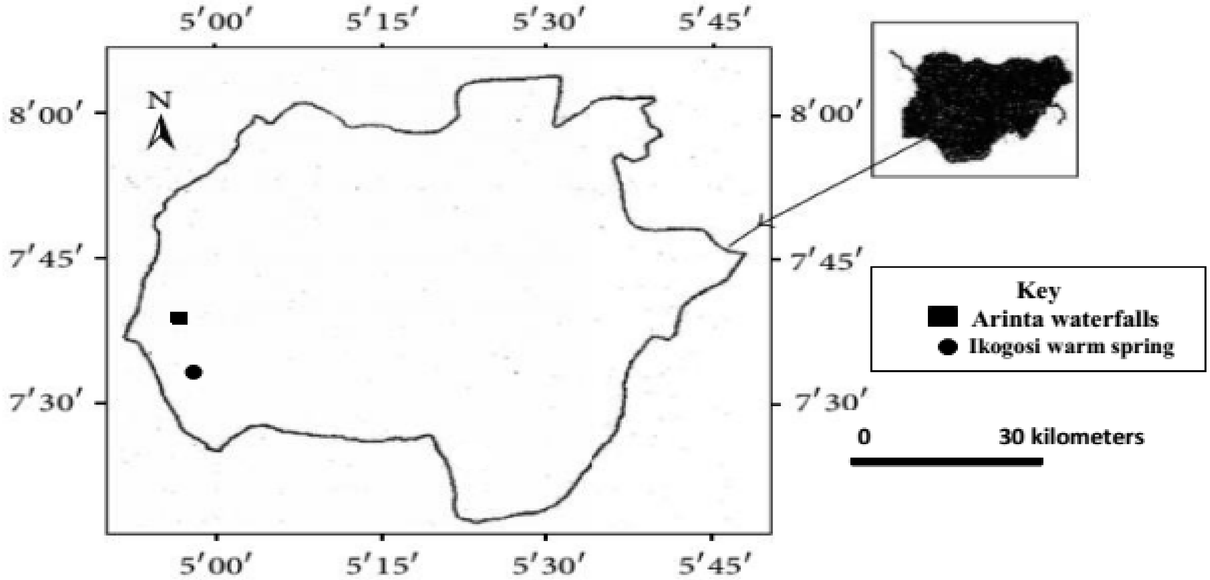

Figure 1: Map of Ekiti State showing the location of the study areas

2.2. Method of data collection

Direct observation and vegetation assessment were used for data collection. Inventory of infrastructural facilities at the study sites was carried out by observation while vegetation assessment was done by enumeration method as described by [14].Two hectares (ha) of land (one close to places where visitors could easily assess and one in the undisturbed area) were measured in each of the study site. Each hectare was divided into four plots of 50 m by 50 m. Two plots were diagonally selected within each hectare to make a total of 4 plots in each study sites. Within each of the selected sampled 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 [18]. The diameter at breast height (dbh) was measured with diameter tape while height of each tree was measured with Spiegel relaskop.

2.3 Data analyses

Diversity Index

Species diversity index (H) was computed using the Shannon-Wiener diversity index given by [19]

$$H^1 = -\sum_{i=1}^{s} Pi \ln (Pi) \quad \text{........... (Equation 1)}$$

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

Species Evenness

Species evenness in each community was determined using Shannon's equitability (E_H) as stated by [20]

$$E = \frac{H^I}{\ln(S)} \quad \text{......... (Equation 2)}$$

S is the total number of species in each community.

$$\text{Sorenson'coefficient } (\beta) = \frac{2c}{s1 + s2} \quad \text{............(Equation 3)}$$

Where C = Total number of species in the two study areas

S1 = Total number of species found in Ikogosi warm spring

S2 = Total number of species found in Arinta waterfall

Species Relative Density (RD)

Species relative density, which is an index for assessing species relative distribution [21], was computed with

$$RD = \left[\frac{n_1}{N}\right] \times 100 \quad \text{................(Equation 4)}$$

Where, RD (%) = species relative density, ni = number of individuals of species, N=total number of all individual trees of all species in the entire community.

Species Relative Dominance (RDo)

Species relative dominance (RDo (%)), used in assessing relative space occupancy of a tree was estimated with

$$RDo = \frac{(\sum Ba_i \times 100)}{\sum Ba_n} \quad \text{……………..(Equation 5)}$$

Where: Ba_i = basal area of all trees belonging to a particular species, Ba_n = basal area of all individual tree

Importance Value Index

The Importance Value Index (IVI) of each species was computed with the relationship;

$$IVI = \frac{(RD + RD_O)}{2} \quad \text{………………………. (Equation 6) [21]}$$

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 [22].

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 warm spring	Arinta waterfall
	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

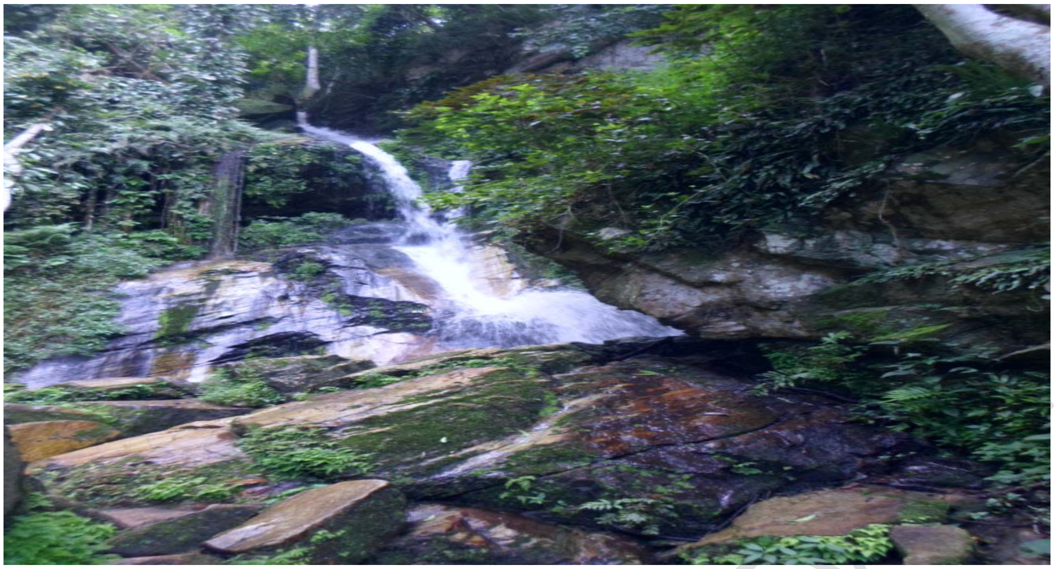

Plate 3: Arinta waterfall

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 a total of 78 species were recorded in the two sites, however the vegetation in Arinta waterfall has higher number of species (66) than that of Ikogosi warm spring with 36 species. The vegetation in Arinta waterfalls has higher number of individual tree (158) than that in Ikogosi warm spring which had 72 tree species in the sampled plots. *Malacantha alnifolia* (5) and *Voacanga africana* (5) were the most frequently enchanter species while *Delonix regia* (3.8 cm) was the tree with the highest diameter at breast height (dbh) and *Ricinodendron heudelotii* (12.88 m) was tree species with the highest height. In Ikogosi warm spring, *Anthocleista vogelii*, *Antiaris africana*, *Delonix regia* were the most common species with frequency of 4 each while *Anthocleista vogelii* (1.64 cm) was tree species with highest dbh and *Brachystegia eurycoma* (12.72m) with the highest height. In Arinta waterfall, *Malacantha alnifolia and Voacanga Africana* were the most common species with frequency of (5 each) while tree species with the highest dbh was *Delonix regia* (3.8 cm) and tree species with the highest height was *Ricinodendron heudelotii* (12.88m). Table 2 also present detail results on species relative density (RD), relative dominance (RD$_0$) and Importance Value Index (IVI) for the studied watersheds *Anthocleista vogelii, Delonix regia* and *Antiaris Africana* has the highest RD value with 5.6 each, while *Anthocleista vogelii* has the highest value of RD$_0$ (15.63) and IVI (10.6) respectively.

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

S/N	Species	Families	Ikogosi warm spring						Arinta waterfall					
			Freq	Dbh	Height	RD	RD$_0$	IVI	Freq	Dbh	Height	RD	RD$_0$	IVI
1	*Afzelia Africana*	Fabaceae	3	0.63	9.15	4.2	2.3	3.24	0	0	0	0	0	0
2	*Albizia adianthifolia*	Fabaceae	3	0.54	12	4.2	1.70	2.94	0	0	0	0	0	0
3	*Alchornea cordifolia*	Fabaceae	0	0	0	0	0	0	2	0.85	9.12	1.27	0.57	0.92

4	*Alstonia booneii*	Euphorbiaceae	2	0.59	8.32	2.8	2	2.39	2	0.76	10.56	1.27	0.44	0.86
5	*Amphimas pterocpoides*	Apocynaceae	3	0.69	8.26	4.2	2.74	3.46	0	0	0	0	0	0
6	*Aningeria robusta*	Fabaceae	0	0	0	0	0	0	1	0.54	7.42	0.63	0.23	0.43
7	*Anthocleista vogelii*	Sapotaceae	4	1.64	11.52	5.6	15.63	10.6	0	0	0	0	0	0
8	*Anthonotha macrophylla*	Loganiaceae	1	0.61	9.2	1.4	2.15	1.77	0	0	0	0	0	0
9	*Antiaris africana*	Moraceae	4	0.47	9.58	5.6	1.26	3.41	3	3.5	12.52	1.9	9.51	5.71
10	*Artocarpus altilis*	Moraceae	0	0	0	0	0	0	2	3.5	12.52	1.27	9.51	5.39
11	*Bombax buonopozense*	Malvaceae	1	0.64	9.92	1.4	2.37	1.88	3	3.5	12.52	1.9	9.51	5.71
12	*Brachystegia evrycoma*	Moraceae	3	0.67	12.72	3	2.59	3.38	2	1.74	11.28	1.27	2.35	1.81
13	*Bridelia atroviridis*	Euphorbiaceae	1	0.47	9.36	1.4	1.26	1.33	0	0	0	0	0	0
14	*Canarium schweinfurthii*	Burseraceae	2	0.92	10.6	2.8	4.89	3.84.	0	0	0	0	0	0
15	*Ceiba pentandra*	Malvaceae	2	0.67	10.8	2.7	2.59	2.69	0	0	0	0	0	0
16	*Chrysophyllum albidum*	Sapotaceae	1	0.59	8.77	1.4	2	1.7	1	0.64	9.92	0.63	0.32	0.48
17	*Cleistopholis pat*	Annonaceae	1	0.59	9.15	1.4	2	1.7	3	0.72	8.48	1.9	0.41	1.16
18	*Cola hispida*	Malvaceae	0	0	0	0	0	0	2	1.68	10.68	1.27	2.19	1.73
19	*Cola millenii*	Malvaceae	0	0	0	0	0	0	1	1.4	11.84	0.63	1.52	1.08
20	*Cola nitida*	Malvaceae	0	0	0	0	0	0	2	1.74	11.72	1.27	2.35	1.81
21	*Daniellia ogea*	Fabaceae	0	0	0	0	0	0	3	0.87	9.15	1.9	0.58	1.24
22	*Delonix regia*	Fabaceae	4	0.47	8.38	5.6	1.26	3.41	2	3.8	11.48	1.27	11.2	6.24

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23	*Dracaena arborea*	Asparagaceae	1	0.47	8.38	1.4	1.26	1.33	0	0	0	0	0	0
24	*Elaeis guineensis*	Arecaceae	2	0.67	11.2	2.8	2.59	2.69	0	0	0	0	0	0
25	*Enantia chlorantha*	Annonaceae	0	0	0	0	0	0	1	1.4	10.88	0.63	1.52	1.08
26	*Entandrophragma cylindricum*	Meliaceae	1	0.62	8.72	1.4	2.22	1.81	3	0.54	10.5	1.9	0.23	1.07
27	*Ficus exasperate*	Moraceae	0	0	0	0	0	0	2	0.54	9.54	1.27	0.23	0.75
28	*Funtumia elastic*	Apocynaceae	0	0	0	0	0	0	2	1.37	10.44	1.27	1.45	1.36
29	*Gilbertiodendron dewevrei*	Fabaceae	2	0.78	9.52	2.8	3.56	3.17	0	0	0	0	0	0
30	*Gmelina arborea*	Labiatae	0	0	0	0	0	0	2	0.6	8.8	1.27	0.35	0.81
31	*Harungana Madagascariensis*	Hypericaceae	1	0.43	9.7	1.4	1.11	1.25	0	0	0	0	0	0
32	*Hollarhena floribunda*	Apocynaceae	0	0	0	0	0	0	1	0.85	12.68	0.63	0.57	0.60
33	*Hunteria umbellata*	Apocynaceae	0	0	0	0	0	0	3	1.64	10.36	1.9	2.09	1.99
34	*Macaranga spinosa*	Euphorbiaceae	2	0.67	9.88	2.8	2.59	2.69	3	0.72	9.4	1.9	0.41	1.16
35	*Malacantha alnifolia*	Sapotaceae	0	0	0	0	0	0	5	0.75	9.48	3.16	0.43	1.80
36	*Mallotus subulatus*	Euphorbiaceae	0	0	0	0	0	0	3	0.7	8.96	1.9	0.38	1.14
37	*Mangifera indica*	Anacardiaceae	1	0.78	9.58	1.4	3.56	2.48	2	0.84	9.98	1.27	0.54	0.91
38	*Milicia excels*	Moraceae	0	0	0	0	0	0	2	0.56	9.12	1.27	0.25	0.76

39	*Milicia regia*	Moraceae	1	0.67	8.64	1.4	2.59	1.99	4	0.92	10.85	2.53	0.65	1.59
40	*Mitragyna stipulosa*	Rubiaceae	2	0.51	9.68	2.8	1.48	2.13	1	0.68	9.12	0.63	0.36	0.5
41	*Monodora myristica*	Annonaceae	2	0.69	9.68	2.8	2.74	2.76	2	0.54	7.52	1.27	0.23	0.75
42	*Monodora tenulfolia*	Annonaceae	2	0.76	9.2	2.8	3.33	3.06	2	2.98	12.32	1.27	6.9	4.09
43	*Musanga cecropioides*	Urticaceae	2	0.68	10.4	2.8	2.67	2.73	2	0.74	9.38	1.27	0.43	0.85
44	*Myrianthus arboreus*	Moraceae	1	0.54	10.8	1.4	1.7	1.55	1	0.76	9.84	0.63	0.44	0.54
45	*Nauclea diderrichii*	Rubiaceae	0	0	0	0	0	0	1	0.6	9.28	0.63	0.3	0.47
46	*Nauclea latifolia*	Rubiaceae	0	0	0	0	0	0	2	0.78	8.16	1.27	0.47	0.87
47	*Nesogordonia papaverifera*	Malvaceae	2	0.78	8.16	2.8	3.56	3.17	2	1.04	9.86	1.27	0.84	1.06
48	*Newtonia buchanani*	Fabaceae	0	0	0	0	0	0	2	0.68	8.26	1.27	0.36	0.82
49	*Nothospondias staultii*	Anacardiaceae	1	0.53	8.7	1.4	1.63	1.51	2	0.52	9.84	1.27	0.21	0.74
50	*Ochroma lagopus*	Malvaceae	1	0.57	11.4	1.4	1.93	1.66	3	2.45	9.88	1.9	4.66	3.28
51	*Pentaclethra macrophylla*	Fabaceae	0	0	0	0	0	0	4	0.78	9.98	2.53	0.47	1.50
52	*Piptadeniastrum africanum*	Fabaceae	0	0	0	0	0	0	3	0.75	9.48	1.9	0.43	1.17
53	*Pseudospondia microcarpa*	Anacardiaceae	3	0.74	10.88	4.2	3.19	3.68	1	0.64	8.48	0.63	0.32	0.48
54	*Pseudospondias mombin*	Anacardiaceae	3	0.57	9.48	4.2	1.93	3.05	3	0.94	10.85	1.9	0.68	1.29
55	*Psydrax arnoldiana*	Rubiaceae	3	0.92	10.88	4.2	4.89	4.53	4	0.76	8.26	2.53	0.44	1.49
56	*Psydrax*	Rubiaceae	2	0.7	9.88	2.8	2.81	2.8	3	0.62	8.16	1.9	0.3	1.10

	subcordata													
57	*Pterocarpus osun*	Leguminosae	2	0.57	9.98	2.8	1.93	2.36	2	0.64	8.15	1.27	0.32	0.80
58	*Pterygota macrocarpa*	Malvaceae	0	0	0	0	0	0	3	1.04	10.98	1.9	0.84	1.37
59	*Pycruanthus angolensis*	Myristicaceae	0	0	0	0	0	0	2	0.76	8.26	1.27	0.44	0.86
60	*Raphia hookeri*	Arecaceae	0	0	0	0	0	0	3	0.6	8.16	1.9	0.3	1.10
61	*Rauvolfia vomitoria*	Apocynaceae	0	0	0	0	0	0	1	1.5	8.96	0.63	1.75	1.19
62	*Rhodognaphalon brevicuspe*	Bombacaceae	0	0	0	0	0	0	3	1.19	9.98	1.9	1.10	1.50
63	*Ricinodendron heudelotii*	Euphorbiaceae	0	0	0	0	0	0	1	0.98	12.88	0.63	0.74	0.69
64	*Rothimannia hispida*	Rubiaceae	0	0	0	0	0	0	2	0.62	9.28	1.27	0.30	0.79
65	*Senna siamea*	Fabaceae	0	0	0	0	0	0	3	0.61	8.34	1.9	0.29	1.10
66	*Spondias mombin*	Anacardiaceae	0	0	0	0	0	0	3	0.52	8.55	1.9	0.21	1.06
67	*Stercospermum acuminatissimu*	Bignoniaceae	0	0	0	0	0	0	2	0.78	9.44	1.27	0.47	0.87
68	*Sterculia rhinopetala*	Malvaceae	0	0	0	0	0	0	4	1.32	11.68	2.53	1.35	1.94
69	*Sterculia tragacantha*	Malvaceae	0	0	0	0	0	0	3	0.78	9.88	1.9	0.47	1.19
70	*Tabernamontana pachysiphon*	Apocynaceae	0	0	0	0	0	0	3	0.95	8.8	1.9	0.70	1.30
71	*Tectona grandis*	Verbenaceae	0	0	0	0	0	0	2	0.48	8.16	1.27	0.18	0.73
72	*Terminalia ivorensis*	Combretaceae	0	0	0	0	0	0	3	1.17	11.42	1.9	1.07	1.49
73	*Terminalia superba*	Combretaceae	0	0	0	0	0	0	2	0.64	8.64	1.27	0.32	0.80

74	*Theobroma cacao*	Malvaceae	0	0	0	0	0	0	3	0.72	9.52	1.9	0.41	1.16
75	*Triplochiton scleroxylon*	Malvaceae	0	0	0	0	0	0	1	0.7	9.36	0.63	0.43	0.53
76	*Uvariastrum pierreanum*	Annonaceae	0	0	0	0	0	0	4	3.57	11.88	2.53	9.90	6.22
77	*Voacanga Africana*	Apocynaceae	0	0	0	0	0	0	5	0.92	8.64	3.16	0.65	1.91
78	*Zanthoxylum gillettii*	Rutaceae	0	0	0	0	0	0	3	0.41	8.64	1.9	0.13	1.02
	Total		**72**	**23.74**	**342.21**				**158**	**73.98**	**648.37**			

3.3 Richness of major plant family in the study areas

Distribution of the tree in the two ecotourism centres by families 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 (Table 3). Malvaceae has the highest species density (15). This was followed by the Fabaceae (12), Anacardiaceae and Myristicaceae with nine (9) each. At Ikogosi warm spring, the families with highest species density include Anacardiaceae, Fabaceae, Malvaceae and Myristicaceae with 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 revealed that Shannon-Wiener diversity index of Arinta waterfall is 4.11 while that of Ikogosi warm spring is 3.48 (Table 4). Result on species evenness of Arinta waterfall was 0.92 while that of Ikogosi warm spring was 0.90. Sorenson's coefficient (SC) of similarity between the species showed a value 0.5. Also the Shannon-Wiener diversity index was 2.65 in Ikogosi warm spring while that of Arinta waterfall was 2.64. 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 showed 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
Sorenson's coefficient		**0.5**		**0.71**

3.5 Vegetation structure and forest characteristics of the study sites

Most of the tree species enumerated around the built-up/ recreational area of the study locations falls 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 was 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: Number of species and characters of trees in different layers in the two sites.

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 just two hectares could support 66 and 36 species. This observation corroborates the report by [23] and [24] 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. Comparatively lower number of tree species recorded at Ikogosi warm could be attributed to heavy presence of recreational/ infrastructural facilities at Ikogosi warm spring (table 1) following the upgrading of Ikogosi warm spring to a resort centre of international standard by the State Government in the recent times. This development has call for clearance of more land and consequent remover of trees in the build-up area. This assertion is in consonance with the findings of [25] 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), *Anthocleista vogelii*, *Antiaris Africana* and *Delonix regia* (4 each) been the most frequently encountered species in the study area. The dominant and the most important species in the study area is *Anthocleista vogelii* as revealed by the IVI (Table 2) while Malvaceae, Fabaceae, Anacardiaceae, Rubiaceae, Moraceae and Euphorbiaceae are the dominant family. This findings corroborated report of [26] that the tropical rainforest ecosystem of south west Nigeria is dominated by these sets of tree species and families. The preponderance of indigenous hardwood species at the two watersheds signifies little human interference. Similar observation has also been reported on tree species composition of Akure Strict Nature Reserve [27].

The high values of the Shannon indices in the two study sites revealed vegetation with very high tree species diversity and abundance. The Shannon indices of 3.48 and 4.11 obtained in the two watersheds are higher than the mean value of 3.34 obtained by [28] for sacred groves in south eastern Indian and closer to the average value (3.66) reported for some tropical rainforest sites in southern Nigeria by [29]. This result is an indication that the biological diversity of the watersheds is adequately conserved probably with local laws and taboos. Since one of the criteria for considering an ecosystem as a good ecotourism destination is its biodiversity richness, the observed floristic diversity of the forests at the two watersheds has great potentials for flora conservation and sustainable ecotourism development.

The slightly higher species evenness value observed in Arinta waterfall shows that the species are more evenly distributed than in Ikogosi warm spring. This result could be attributed to higher number of trees in the middle layer to form a continuous canopy. The horizontal and vertical structure of the forest at the watersheds as revealed by the diameter and height distribution indicates a forest structure that is immature and still expanding. This is evident in the floristic composition of the two watersheds which are within the middle and understorey layer with small stem (Table 5). The predominantly middle and lower stratum vegetation of the two study sites especially the Arinta waterfalls could be an added advantage to a sustainable ecotourism sites if properly managed. This lower stratum with well-formed canopies could provide resting shade for visitors to the ecotourism centres. This assertion corroborates the submission of [30]

Observation from the study also revealed that some species are threatened and endangered, such species include *Anthonotha macrophylla, Aningeria robusta, Bridelia atroviridis, Cola milenii Dracaena aborea, Harungana madagascariensis,Hollarhena floribunda, Ricinodendron heudelotii, Rauvolfia vomitoria, Triplochiton scleroxylon and Nauclea diderrichii* which were encountered once at the study sites. The implication of this is that by the virtue of their narrow range, they are vulnerable to extinction if proper conservation measures are not put in place.

5. CONCLUSION

Results from this study have revealed that the vegetation of the study area is a repository of many tree species with great potential for floral conservation and sustainable ecotourism development. Also the study has revealed that species diversity and abundance at the watersheds compared favourably with other similar forest ecosystem in the region .The study also revealed that the species composition at the two watersheds are within with middle and understory layers with small diameter indicates an immature forest structure that is still expanding. Observation from the study also revealed that some species are threatened and endangered. Consequent upon these results management strategies should be put in place to improve status of the watersheds. This could be done by involving the local communities in the planning and policy implementation meant protect the watershed from encroachment. Also conservation efforts should be stepped up for species with rarity index value to prevent them from going into extinction.

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