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Research Article

In Situ Forest Biodiversity: Integrating Indigenous and Local Knowledge Systems into Conservation Policies in Southwestern Nigeria

John Langton*

Department of Geography and Environment, University of Oxford, Oxford, UK

ABSTRACT

Biodiversity loss has become a major problem in Southwestern Nigeria because 70%-80% of its forest has been converted to non-forest uses. Modern conservation systems have not yielded desired result because the techniques had proved inadequate in addressing conservation issues. The study is therefore an assessment of indigenous and modern methods of forest management in Southwestern, Nigeria. Primary and secondary data were used in this study. The secondary data (inventories of woody species, lists of communities within the buffer zone, types of forest resources and conservation techniques) were obtained from Osun-Osogbo Sacred Grove (OOSG) and Old Oyo National Park (OONP) records. Quadrant method was used for sampling of the woody species. The study sites consisted of eight plots of 50 × 50 m along two 300 m long transects. One Way ANOVA, Relative Species Index, Species Diversity Index (SDI), Important Value Index and some descriptive methods, such as; tabulation, percentages, mean and standard deviation were used to analyze the data. The findings of the study were that: Biodiversity index was higher under indigenous conservation method at OOSG of (3.48) compared to OONP (3.14) under modern conservation method and the Species Diversity Index (SDI) suggests that both indigenous and modern techniques of forest conservation encouraged biodiversity conservation (SDI 3.01-8.27).This study concluded that indigenous conservation techniques yielded better conservation results and contribute to biodiversity integrity of the study area. The study recommended that there should be a policy that will strengthen and integrate existing indigenous practices to further make stronger conservation efforts.

Keywords: Biodiversity; Indigenous knowledge; Modern; Conservation; Nigeria

INTRODUCTION

Forest biodiversity is of importance in environmental conservation. Forest resources play a key role in protecting the environment and can be sustained either by modern or indigenous systems the outcome of any will affect forest resource management. In Nigeria, forest resources continue to attract more attention due to their significance in biodiversity conservation, carbon sequestration and livelihood support. Rich and diverse types of indigenous, traditional forest and pasture management practices vary throughout Nigeria according to different cultures, locations, climatic conditions and socio-economic situations.

Conservation of biological diversity is essential for efficient functioning of the earth ecosystem. Forests are ideal habitats for a wide range of flora and fauna some of which are endangered species. Forests create vertically stratified habitats upon which nearly all other forest dwelling organisms such as micro-organisms, small plants, insects, reptiles, birds, and animals depend.

Forests are especially substantial in terms of their potential for triggering subsequent changes in biodiversity within and among associated organisms. This is because they exert such a major effect upon all lives above, amidst and beneath them. Forests also influence local and regional climates and soils as well as serve as checks in the loss of biological diversity and the species of plants composing various ecosystems.

In situ conservation is an ideal method to protect ecosystems in their natural habitats especially now that there is substantial evidence of increasing loss of biological diversity globally The accelerating rates of loss of floral and faunal species and the projected negative impacts of this loss of germplasm on humankind have been expressively described by a growing number of prominent scientists and numerous international organizations and development agencies [1].

Decline in biodiversity is increasingly becoming one of the major concerns of humankind since the last quarter of the 20th century. In highlighting this view, the 2002 World Summit on Sustainable Development, held in Johannesburg-South Africa,

Correspondence to: Dr John Langton, Department of Geography and Environment, University of Oxford, Oxford, UK, E-mail: jlangton46@yahoo. com

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declared that despite significant efforts, the decline of biodiversity worldwide continues at an unprecedented rate and that a reversal in this ongoing decline should urgently be achieved observes that the reversal of biodiversity decline has become one of the major challenges that the world faces today. It is from such reality that biodiversity decline is increasingly becoming a worldwide challenge that requires collective and urgent efforts at local and international levels. Biodiversity is already being reduced, degraded, and hugely threatened across the planet. This situation points to the destruction facing environmental systems and resources. In spite of all these, biodiversity resources, if sustainably managed, still give the hope for ensuring the much desired sustainable livelihoods and development.

Forest covers 3999 million hectares of the world (FAO, 2015). At present, thirty-one percent of earth's total forest is in Asia, followed by 21% in South-America, 17% in Africa, 17% in North and Central America, 9% in Europe, and 5% in Oceania (FAO,2010). The global forest resources assessment in 2000-2010 revealed that Nigeria lost about 410,000 ha (3.7%) of its natural forests to deforestation [2].

The loss of biodiversity is an issue of profound concern for its own case in the tropics, more than elsewhere. Any subtle changes in dominant forest cover may lead to key changes in plant species composition and consequently, food chain dynamics that may in turn introduce much greater and clearer losses in local and regional biodiversity.

Indigenous and modern biodiversity systems are both phenomena essential to human development. Continuous loss of biodiversity has major implications for current and future human wellbeing. The individual components of biodiversity-genes, species and ecosystems provide our society with a wide range of goods and services. Some of the ecosystem services potentially threatened by declining and changing biodiversity are provision of foods, fibre, medicines and fresh water, pollination of crops, filtration of pollutants, and protection from natural disasters. Most conventional forest conservation methods are institutional based and do not integrate the knowledge of local communities that have interacted with the forest for centuries. In Nigeria, local communities' participation in biodiversity conservation comes in various forms but sacred groves are the most widely practiced especially in the tropical rainforest [3].

The tropical rainforest zone of Nigeria is relatively small, accounting for only 9.7% of the country's land area of 983,213 km^2 14.3% of the forest area of 234,004 km^2. Rain forests in Nigeria are under pressure and have showed signs of human activity even before colonial times

Though there were evidence of forest conservation in Nigeria before the creation of forest reserves during the early 20^{th} century, a lot of indigenous communities have age-long traditional systems (sacred groves) for protection of plant and animal species before the advent of conventional biodiversity reservation (National Park or Forest Reserve).

In Nigeria, as in many other countries such as India, Tanzania, Ghana, Kenya and others, people used to set aside tracts of forestland because they believed that a particular patch of forest had a resident god/goddess protection. Thus, nature conservation has been an ancient tradition practiced by societies globally. Indigenous knowledge of biodiversity and socio-religious values for long term conservation has been considered important for sustainability of biodiversity. In addition to indigenous knowledge systems of conservation through sacred groves, there are concerns for conservation of residual forest which are universal. These includes the conventional government reserved forests like National parks, forest reserves, gene reserves, biosphere reserve and others [4].

The indigenous knowledge emphasizes a resourceful use and management system in which local knowledge is applied and an appropriate set of practices, tools and techniques evolves locally such as the establishment of sacred locations, customary laws, taboos and social norms in biodiversity conservation. On the other hand, the modern knowledge system interchangeably referred to as scientific, conventional and exclusionary approach exists through the establishments of protected areas such as national park, forest reserves, gene reserves, and biosphere reserves.

These modern conservation measures, however, have failed to fully integrate other important factors, such as social, cultural, and political issues. Such an outcome can undermine conservation objectives through conflicts between parks or forest reserve managers and local communities.

Biological diversity and sustainable resource use are critical for ecosystems stability and human existence. Forest biodiversity is today under assault globally, due to rapid and accelerating anthropogenic activities causing persistent decline in species diversity [5]. Many forest values are threatened as a consequence. The scale and immediacy of these threats have attracted the global community's interest on the necessities of forest conservation and sustainable forest management to protect forest biodiversity.

Even though quite a few efforts have been made to examine the place of indigenous and scientific knowledge in environmental management in different parts of the world including Nigeria such as in Bayelsa, and other parts of Nigeria, not much work has been done in Southwestern Nigeria and most especially on comparative basis, on this issue.

The study presents a framework of the role indigenous and modern knowledge systems play in the conservation and management of *in situ* forest biodiversity in a sacred grove and a national park in Nigeria. However, data on the biodiversity intactness index in both our conventional forest reserves such as in National Park and local sacred forests grove are scanty and the effect of these conservation methods on genetic resources present in protected areas has not been assessed [6]. This paper therefore attempt an assessment of the impact of Osun Osogbo Sacred Grove a site identified famous for the practice of indigenous knowledge system and old.

Oyo National Park, a modern and scientific-based protected area established by an act of Parliament for the protection of biodiversity. Hence, the rationale for this paper is to see contribution of indigenous sacred grove and the modern state managed forest resources conservation strategies, in harnessing biodiversity status are assessed.

MATERIALS AND METHODS

Study area

Southwestern is one of the six geopolitical zones of Nigeria. It is located within latitudes 6°45'–8°45'N and Longitudes 2°50'–5°56'E. The zone comprises six contiguous states namely Oyo, Osun, Ondo, Ogun, Ekiti and Lagos (Figure 1). This zone is also known as Yorubaland, being predominantly occupied by people of Yoruba extraction. It is located in the heart of the tropical rainforest region.

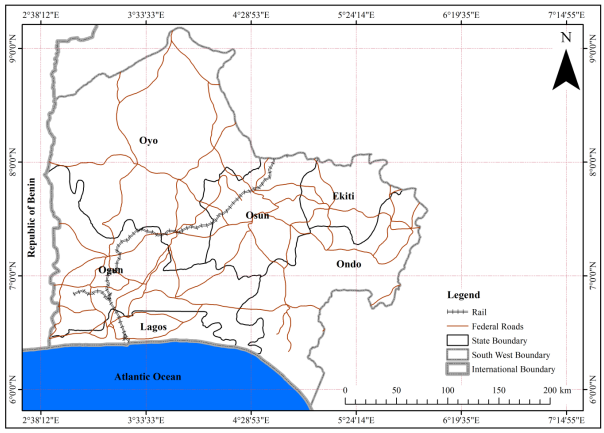

Figure 1: Southwest Nigeria.

Oyo State is located between latitude 60 55"80 45" and longitude 205"30 56" in southwestern Nigeria. It is bound by the Republic of Benin, Kwara State, Osun State and Ogun States on the West, North, East and South respectively. The state is divided into 33 Local Government areas for administrative purposes. It covers an area of about 28,454 square kilometers (10,986 sqkm) has a population of 5,591,589 as at 2006 census. Osun State is situated in the tropical rain forest zone. It covers an area of approximately 14,875 sq km and lies between latitude 703'0' and longitude 405"-30'0' in the southwestern Nigeria (Figure 2).

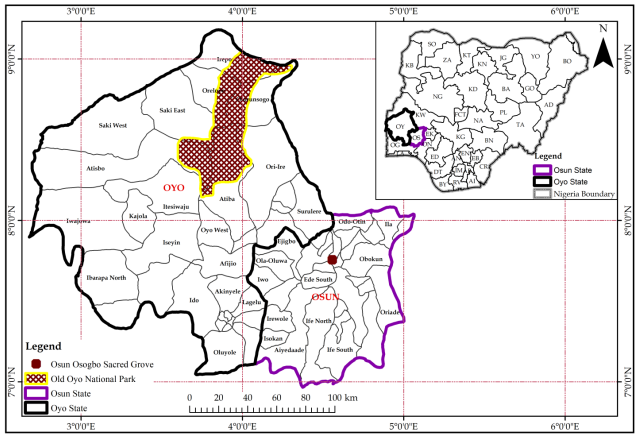

Figure 2: Osun and Oyo States, Southwest, Nigeria.

Source: Federal Survey Office, Ibadan (2017). Osun state was carved out of Old Oyo state on 27th August, 1991 with Osogbo as the state capital. The state shares interstate boundaries with Kwara state in the North, Ogun state in the south, Oyo state in the west and Ondo state in the east. The state has a landmass of about 9,251km^2.It is currently made up of 30 Local Government Areas spread across six main zones–

Source: Federal Survey Office, Ibadan (2019). Osogbo, Ede, lwo, lkirun, llesha and lle-lfe. Estimates in the recently released provisional figures of the 2006 census put Osun state human population at 4.137627 million (NBS,2006) as at March 2005. Osun state is located in the heartland of the Yoruba people and shares the distinctive high urbanization attributes of most parts of Yoruba land with Yoruba as the main dialect [7].

The major sub-ethnic groups in Osun are Ife, Ijesha, Oyo, Ibolo and Igbomina of the Yoruba people, although there are also people from other parts of Nigeria. People living in Osun State practice Islam, Christianity and paganism called traditional faith. Osun Osogbo Grove (Igbo Oroo), is located outside Osogbo town in Osun state and dedicated to Osun goddess. The sacred grove (Igbo Oroo) has been Nigeria's national monument and a UNESCO World Heritage site since 2005.The grove covers an area of 75 hectares (Osun Osogbo Sacred Grove Guide, 2017).Owing to increasing population and, hence, increasing population pressure on land, deforestation is visibly taking place in the whole of Southwestern Nigeria. Loss of biodiversity is equally an ecological problem experienced in the area [8].

Southwestern Nigeria generally has a tropical climate type with distinct periods of wet and dry seasons. The mean annual temperature is 21°C, average daily temperature ranges between 25°C and 35°C while the annual rainfall ranges from 1000 mm to 1600 mm. The wet season is between 230 to 260 days/year. Relative humidity is generally above 60% during the day and not less than 70% in the night. For instance, the annual rainfall in the park ranges between 900 mm and 1500 mm, and mean annual temperatures range between 12°C and 32°C. The park experiences the harmattan period from November through February. During this time, night temperatures are quite low.

Oyo State is divided into three major ecological zones, based on the differences in the vegetation type. The ecological zones are the following: The Guinea savannah ecological zone is located in the northern part of the state. The vegetation consists of open woodland, tall grasses (1 to 3 m high) and trees that are less than 15 m in height. Animal husbandry dominates this ecological zone. The Derived savannah ecological zone is found in the southern half of Oyo State. This zone developed as a result of intense deforestation due to agricultural activities on the forest area. Areas left to re-grow favour grasses and shrubs that are susceptible to fire. Arable cropping dominates this ecological zone.

The Lowland Rainforest ecological zone occupies south of the Derived Savannah zone. Lowland Rainforest portrays three stratum/storeys. This comprises the top with isolated wide spreading crowns; the middle with a large number of species with small crowns; and the under storey made up of woody climbers and short trees with spreading crowns. Most of the tree species are used for timber production. Tree crop agriculture is the dominant land use in this zone.

The Old Oyo National Park (OONP) is located in the state and it is one of the eight National Parks in Nigeria. It covers a land area of approximately 2,512 km access (i.e 251,200 ha) making it the fourth largest Park in Nigeria. The Park lies within southern Guinea Savanna zone with mixed forest trees and Savannah Woodlands zones, The vegetation of the park has been delineated into forest and dense savanna woodland in the south, dense and open savanna woodland, dense savanna woodland and open savanna woodland. The National Park lies within southern guinea savanna zone with mixed forest trees and savannah woodlands zone. The vegetation of the Park has been delineated as follows:

- Forest and dense savanna woodland in the south;
- Dense and open savanna woodland mosaic in the central portion;
- Dense savanna woodland North of Igbeti–Kishi axis; and
- Open savanna woodland of the Northeastern axis.

Dominant tree species include Afzelia Africana, Vitellaria Paradoxiuum, Annogeeissus Leiocarpus,Ceibapentandra, Bombax Spp amond others. Most soil in Oyo state belongs to the savannah group of soil (Oyo State Soil Survey Division, 1990).

In undulating areas, the soil is composed of sand, and sandy loam, while in areas that are nearly level, savannah soil comprises sandy loam with some gravel. Rainforest soil is found in the southeast part of Oyo state. The soil consists of loam, sandy loam, and clay loam. The soils of Osun state are generally deep and are of two types, namely, deep layer soils formed on low smooth hill crests and upper slopes and sandy hills-wash soils on the lower slopes. The soils belong to the highly ferruginous tropical red soil associated with basement complex rocks.

Osun State has natural lowland tropical rainforest vegetation but this has since given way to secondary forest re-growths. Among the reasons for this are fuel wood production, road construction, clay and sand quarrying and traditional farming practices. Human interference by way of cocoa plantation has also replaced the forest. Hence, the natural tree species have given way to oil palm (elacis quinuiensis) guieline and dense thickets. The dense forest of the Osun Osogbo Sacred Grove was unique with distinct strata, and dominated with species which usually predominant towards or at climax level of the plants succession.

Data required for this study include the roles of sacred grove and national park in biodiversity conservation and biodiversity status of the study sites in terms of species relative indices, and species relative dominance (diversity indices),species abundance.

Also a combination of personal observations method was employed in the field on the current use of environmental resources especially forest in the areas and the species available. This allowed the researcher to record what is on ground. The advantage of this method according to Asika is that the information so gathered is usually thorough. The more the researcher participates in and observes these activities, the greater the thoroughness and reliability of information gathered, Fieldwork activities were conducted to establish the biodiversity conservation potential of the grove and the national Park. Line transect was used to conduct rapid survey of tree diversity within the grove and the national Park. Three lines transect of 100 m long and at a distance of 50 m apart were laid within the sacred grove and the national park. Tree species within 20 m on either sides of the line transect were identified and recorded accordingly. Four plots of size 50 × 50 m were each laid on two transect lines of length 300 m. The plots were laid in the middle of the sacred grove and compartment of the 3 out of the 5 Ranges in Old Oyo National Park namely: Plots of size 50 × 50 m were laid on two transect lines of length 300 m each and separated from each other by 300 m every 75 m along each transect, giving total of four plots per transect and eight in total for each study site giving a total of sixteen for the study. Within each plot, all living trees with diameter at breast height (DBH) ≥ 30 cm were identified and their DBH measured.

Species Relative Density (RD) and species Relative Dominance (RDo) of each site were computed using equations 1 and 2. This method is especially important in determining species composition of the sacred grove, Osogbo and the habitat in OONP covering the five ranges in the park in OONP.

$$RD = n / N * 100 \quad \text{.....1}$$

Where:

RD=Relative Density,

n=number of individuals per species and

N=Total number of individuals in the entire population.

$$\text{RDo} = \sum Ba2 * 100 - \sum Ba_{\text{n}} \quad \text{.....2}$$

Where:

RDo=Relative Dominance

Bai=Basal area of individual tree belonging to the i^{th} species and

Ban=Stand basal area.

Species diversity index was calculated using Shannon–Wiener diversity index (3)

A common methodology has been set up for the research work at the study sites, Osun Osogbo Sacred Grove and OONP. As a standard sampling procedure for woody species, eight plots of size 50 × 50 m were each laid along two 300 m long transects. The plots were laid in the middle of the sacred grove and compartment of the 5 Ranges in Old Oyo National Park namely: Plots of size 50 × 50 m were laid on two transect lines of length 300 m each and separated from each other by 300 m, every 75 m along each transect, giving a total of four plots per transect and eight in total for each study site giving a total of sixteen for the study. Within each plot, all living trees with diameter at breast height (DBH) ≥30 cm were identified and their DBH measured. Tags were placed 15-20 cm below a painted ring marking DBH for accuracy. When repeating that measurement for Osun Osogbo Sacred Grove and OONP, data on trees species, DBH (cm), and Height (m) of all tagged trees were recorded, and then the densities, frequencies, and basal errors for each species were calculated.

Further, species composition and the structural characteristics of the trees inside the four 50 × 50 m plots were investigated to obtain their basic stand information which include the Important Value Index (IVI) that is the sum of the percentage of relative diversity, relative frequency and relative dominance. Species and family dominance were determined by the Importance Value Index (IVI) which is given as the sum of Relative Frequency (RF)+Relative

Density(RD)+Relative Abundance(RA). While the dominant species were determined as the species with the highest IVI value, the dominant family was determined as the sum of IVI value of all species to a particular family.

The IVI was given as:

$$\text{RF}\left(\text{a} / \text{b} * 100\right) + \text{RD}\left(\text{c} / \text{d} * 100\right) + \text{RA}\left(\text{a} / \text{q} * 100\right) \quad \text{.....3}$$

Where:

a=species frequency

b=sum off all species frequencies

c=number of individuals of a species

d=total number of individual species

q=total quadrat in which the species occur

*=multiplication formular

Species Richness D=S/N 4

Where: D=the Menhinick index in the sample

S=the number of different species as presented in the sample

N=the total number of species in the sample.

Species diversity index calculated using Shannon-Wiener's equitability index (En) equation was adopted from estimating species evenness .and their exponentials (exp H') were computed based on

$$H\text{^}' = \Sigma(i=1)\text{^}s[P\ In\ (Pi)\text{^}] \quad \text{..... 5}$$

Where:

H'=Shannon diversity index,

S=total number of species in the habitat,

Pi=proportion of S which made up of the i^{th} species and

ln=natural logarithm.

One-way ANOVA technique was employed to determine the differences within the tree species parameters in Osun Osogbo Sacred Grove for biodiversity measurement. Duncan's New Multiple Range Tests was used to draw conclusions on various parameters studied in both Osun-Osogbo and Old Oyo National Park.

Measurements: Participants were asked several questions about cognitive complaints. The first ("Do you have memory problems?"), with two possible answers (yes/no), was put to all participants aged over 55. Those answering "yes" were asked a further six questions based on the SCD and SCD plus criteria (Table 1); all were yes/no questions, with the exception of question 7, with three options (<2 years, 2-5 years, and >5 years); for the purposes of our study, responses to this question were categorized as up to five years (1 point) and more than five years (0 points). These seven questions were synthesized into a scalar variable (the "SCD-7 index") that draws on fundamental aspects of SCD as described and the SCD-I Working Group.

Table 1: Tree parameters indices from the study sites.

Biodiversity index/tree characteristics	Sacred grove (Indigenous knowledge)	National Park (modern knowledge system)
	Osun Osogbo	OONP
No of tree families	20[ab]	29[a]
No of tree species (richness)	62[a]	31[ab]
No of seedling species	65	52
No of endangered species	18	14
Diversity Index (H')	3.48[a]	3.14
Species Evenness (E0)	0.65[a]	0.58[b]
Mean basal area (m2\ha)	42.5	86.4
Mean dbh (cm)	28.4	15.1
Maximum dbh (cm)	158.8	117.2

*=Number of species, a,b=Values in Parentheses are percentages of the number of endangered species values followed by the same letter within the same row and they are not significantly different ($p< 0.05$).

Cognitive performance was objectively assessed with five questions on orientation in time: Day, date, month, season, and year. These questions are taken from the Mini–Mental State Examination (MMSE) and measure several cognitive areas, particularly memory. Orientation in time is associated with episodic and working memory, and shows a positive correlation with total MMSE score. The global score for the variable was the sum of the errors made by each respondent.

General mental health was measured using the Goldberg General Health which is available in 60-, 30-, 28-, and 12-item versions; we used the 12-item questionnaire. HRQoL was assessed with the COOP/WONCA, with nine items from the full version used as verbal stimuli. The validity and reliability of this format have been demonstrated in the Spanish population .Depression, anxiety, and other diseases were assessed with questions phrased "has your doctor told you that you have ?"; this form of survey is common in population studies .Other health and social variables were evaluated with direct questions about sleep, pain, loneliness, etc.

Statistical analysis

The dependent variable used was the SCD-7 index, the sum of the answers to the questions on SCD. Categorical variables were codified, with higher scores indicating greater burden or severity. According to whether variables were categorical or scalar, associations between the dependent and the independent variables were studied with ANOVA, with an R^2 effect size; or contingency tables with a Cramer's V statistic (interpreted according to the criteria established by Cohen for effect size and a Pearson correlation coefficient. We created the variable "vascular risk factors," comprising the dichotomous scores for the variables hypertension, dyslipidemia, and diabetes. Another variable, the "pain index," constitutes the sum of all pain-related variables (pain [no pain, 0; mild, 1; moderate/intense, 2], low back, pain neck, migrainearthritis, taking was scored from 0 to 7. A linear regression analysis was performed to identify predictors, with the R^2 and beta statistics used to calculate effect size. Some participants did not respond to any question; these were classified as missing cases and excluded from the analysis. Statistical analysis was conducted using SPSS version 20.0.

RESULTS AND DISCUSSION

Impact of osun osogbo sacred grove on biodiversity conservation and species composition in Southwestern Nigeria

Osun Osogbo grove has the highest species richness (60) diversity index (3.56), number of seedlings (65 species), species evenness (0.66) and percentage of endangered species (32.8%) which indicated its importance as *in situ* biodiversity conservation.

However, the lower diversity indices of Old Oyo National Park are attributed to its ecological location in the savannah ecological zone and low sacredness which has led to encroachment. In the case of OONP the highest species richness (50) diversity index (3.27), number of seedlings (55), species evenness (0.56), and percentage of endangered species (26.7%) respectively, also showed the Park's importance in *in situ* biodiversity conservation.

The sacred grove not only has a greater number of species present, the individuals in the community are distributed more equitably among these species. Other species family in Osun Osogbo grove includes mimosordaceae, apocymaceae, ulimaceaee, sterculiceae, among others. The maximum dbh of trees in all sites varied from 90.4 to 154.4 cm, with Osun Osogbo grove having the highest value and lowest in OONP. The lowest, mean dbh (ranges between 21.8 to 34.5 cm) was highest in Osun Osogbo's plot and lowest in OONP (mean: Ranges from 11.3 to 15.1 cm) forest. Except for degraded forest in OONP, mean dbh values in all other sites were not significantly different. Basal area ranged from 66 to 18.9 m2/ha and was significantly different between the sites. The largest individual trees were encountered in Osun Osogbo grove, followed by OONP's degraded forest. This result is in agreement with the results of Oyeleke and Onyekwelu [5]. Some of these values are shown in Figure 3.

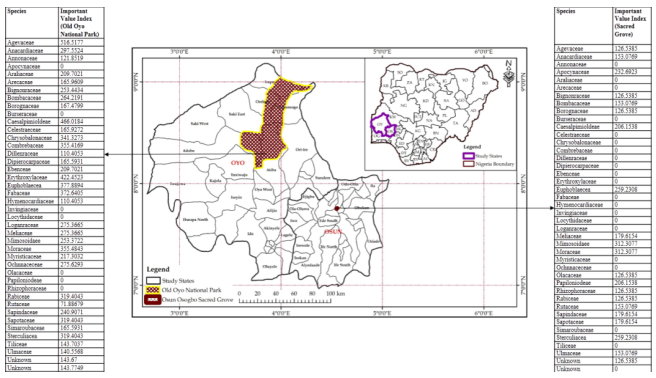

Figure 3: Map of OONP and the Grove and the Tree diversity.

Number of tree species encountered in all the sites varied from 27-65, with Osun Osogbo grove having the highest species abundance and the OONP having the least abundance species. Therefore, species abundance in Osun Osogbo Sacred Grove was significantly higher than those of OONP. The conservation of endangered species is fairly similar in the rest of the ecosystems. Shannon-Wiener diversity index ranged from 2.35 to 3.54 in the two sites, with Osun Osogbo having the highest and OONP the least values respectively. Earlier, Shannon-Wiener diversity, indices of the two ecosystems under investigation was subjected to statistical analysis after the exponentials (exp. H') were computed.

Members of Sterculiaceae, Moraceae, Euphorbiaceae, Apocynaceae, Caesalpimiolaeae, Ebenaceae, Agavaceae and Mimosoidaceae families were dominant in the two ecosystems while members of Burseraceae, Ir vingiaceae,, Ulmaceae Tiliaceae, Lecythidaceae, Hymenocardiaceae were the least dominant. Based on species relative dominance and IVI, tree species that dominated the two ecological sites were *Ricinodendron heudelotii*, *Celtis zenkeri* and *Cola* spp. Species with high relative density included *Holarrhena floribunda* (12.05), *Cola millenii* (10.05) and *Celtis zenkeri* (8.75) in Osun Osogbo grove, *Hildegardia barteri* (38.46), which agrees with results of our current study.

In addition, members of Mimosoidaceae, Annonaceae, Sapotaceae and Bombacaceae are also important floristic composition of some of the sites. Diversity index in this study was within the range reported by Adekunle and Onyekwelu,Onyekwelu and Olusola but higher than the values . Diversity index for Osun Osogbo (3.54) and OONP (2.35) were higher than values (1.2-1.4) reported for sacred groves in Tanzania. The non-significant species evenness values for all sites suggested that trees species distribution was similar in all the sites.

A higher number of tree species has been reported in some sacred groves in Sierra Leone and Kerala, India than in Osun Osogbo.

Lower tree species richness in Osun Osogbo grove could be site-specific rather than indication of their poor biodiversity conservation status. Tropical rainforests of Southwestern Nigeria are inherently poor in tree species, with number of tree species rarely more than 70 ha. Members of Meliaceae, Sterculiaceae, Ulmaceae, Euphorbiaceae and Apocynaceae dominate Nigerian rainforests. Agavaleae apocynaceae (11.47) and caesalpimioldeae (9.35) in Old Oyo National Park ecosystem. High concentration of endangered tree species in sacred groves in this study is another indication of their important role in *in situ* biodiversity conservation, which is in agreement with some published results.

Given the prevalence of endangered species in Osun sacred grove, it could be used to promote *in situ* conservation of endangered species as a repository of rare and endemic species.

Under the sacred grove system, forest preservation is secured using taboos, cultural and religious beliefs or by dedicating the forest to deities as was the case in Osun Osogbo. As a result of respect and fear of the taboos and deity, people keep away from the sacred grove. The role of sacred groves in biodiversity conservation is attracting increasing attention of international Organizations like UNESCO, IUCN, WWF and UNEP.

Values in Parentheses are percentages of the number of endangered species values followed by the same letter within the same row. They are not significantly different (P<0.05).

Impact of national park on biodiversity conservation and species composition in Southwestern Nigeria

Though the biodiversity indices of the Old Oyo National Park were poorer than that ofOsun-Osogbo grove, they were comparable with those of degraded and primary forests in other tropical parts of Nigeria. The poorer biodiversity conservation status of OONP in comparison with Osun Osogbo can be attributed to the climatic zone of the site which is Savannah ecological zone. In addition, OONP assumes a low-sacredness status. Its operation is based on conventional and scientific conservation technique, as only less than 5% of the community dwellers see the grove as the home of deity and place of worship. On the other hand, 90% of community dwellers see OONP as a protected, historical and cultural site and this has led to significant conservation (Table 1). Since people have no cause to be afraid of the deity and taboos associated with OONP, there have been encroachments in the fringe, which may have led to erosion of some tree species.

In the OONP, where biodiversity conservation practices involved a scientific tool, there are 17 fewer species and 70% of the individuals belong to one species such as agavaleae, moraceae apocynaceae, caesalpimioldeae, and euphoblecea while euphoblecea, is the most common species in the sacred grove, and makes up about 14% of the community This result is similar to that of Alarape in the same area showing the relationship between the two sites (Figure 4).

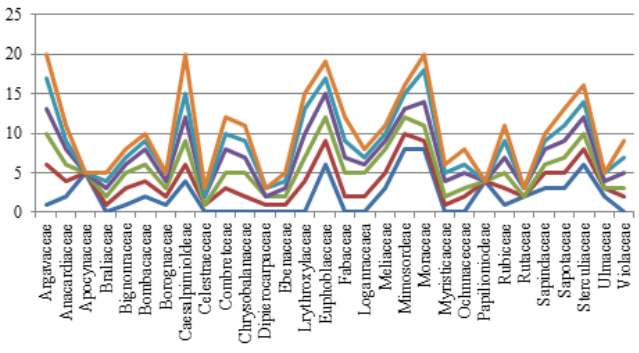

Figure 4: Relationship between the species families in Osun Osogbo sacred grove and the OONP.**Note:** (——) (A)Sacred Grove, (——) (B) Old Oyo NP, (——) (C)Old Oyo NP, (——) (D)Old Oyo NP, (——) (E) Old Oyo NP,

Number of tree species encountered in all sites varied from 31 to 62, with Osun Osogbo grove having the highest species abundance and OONP having the least abundance. This is in line with the results of Onyekwelu and Olusola, which stated that in the whole southwest, apart from Queen's forest in the south west region,

species abundance in Osun Osogbo grove was significantly higher than any other primary and degraded forests. Between 24.7 and 33.3% of tree species in the two sites were classified as endangered species in Nigerian forests. Except for the lower percentage of endangered tree species present in primary forest at the Old Oyo National Park, the conservation of endangered species is fairly similar in the rest of the similar sites in the southwestern Nigeria. Shannon–Wiener diversity index ranged from 3.14 to 3.48 in the two sites, with Osun Osogbo grove having the highest and OONP with lowest values respectively and the diversity index was statistically similar in the two study sites. Species evenness ranged from 0.58 to 0.65 and was statistically similar in all sites.

There is evidence of high concentration of endangered tree species in Osun sacred grove which is an indication of its importance in *in situ* biodiversity conservation (Table 2). This results is in agreement with the reports. The prevalence of endangered species in Osun Osogbo Sacred Grove more than that of OONP, could therefore be used to promote *in situ* conservation of endangered species.

Table 2: List of Five Dominant Tree Species in each of the Study Ecosystems.

Family	Species	Frequency	Conservation Status	Mean dbh(cm)	RDo (%)	RD (%)	IVI
Osun OsogboSacred Grove	-	-	-	-	-	-	-
1.Euphorbiaceae	*Ricinodendron neudolotii*	12	Endangered	27.2	2.92	4.58	3.52
2.Mimosoideae	*Allizia Zygic*	10	-	41.5	5.36	4.78	5.12
3.Apocymaceae	*Helarrhena floribunda*	26	-	24.8	5.37	12.05	8.27
4.Ulmaceae	*Cellis Zenkeri*	20	-	29.2	6.48	18.75	3.76
5.Sterculiceae	*Cola millenii*	21	-	19.2	2.65	10.08	6.18
Old Oyo National Park	-	-	-	18.2	5.02	11.47	5.64
1.Agavaleae	-	28	-	20.1	3.48	4.01	3.48
2.Apocynaceae	*Allizia zugia*	18	-	15.4	2.63	3.87	6.75
3.Caesalpimioldeae	*Astonia boonei*	14	-	16.4	3.97	9.35	7.12
4.Moraceae	*diaspyros*	12	-	-	-	-	-
5.Euphoblaeae	-	-	Endangered	21.7	2.02	3.98	3.01

Note: DBH: Diameter at Breast Ḥeight; RD: Relative Density; RDo: Relative Dominance.

In comparing the species composition in the two sites, there was a total of 101 seedling species. With 65 seedling species, regeneration was highest in Osun Osogbo, followed by OONP with the 36 seedling species respectively. Regeneration (number of seedlings) of *Diospyros* spp (Ebony tree), *Cola* spp (Kola nut), *Sterculia rhinopetala* (star chest nut) and *Carpolobia lutea* was high in all sites. Species with high number of seedlings in specific sites were *Alchornea cordifolia*, *Cola millenii, Brachystegia eurycoma* in Osun Osogbo, *Albizia zygia* (Okuro) *Myrianthius arborius, Rianodendron herudolotii,* and *Diospyros* spp. have the highest number encountered as evident in the five sectors namely in Old Oyo National Park.

Those with the highest number of species were Apeocymaceae, Ulmaceae, Sterculicea occurring in Osun Osogbo, while Agavaleae, Caesalpiniodeae, Apocynaceae occurring in OONP 28, 18 and 14 species correspondingly were taxonomically diverse and made up the largest groups of taxa in especially Osun Osogbo Sacred Grove and the five sectors in OONP . The results is similar to that of Alarape and Tijani in Old Oyo National Park, furthermore, Apocymacaeae had the highest IVI owing to the high density of its constituent species Holarrheaa floriomida for Osun Osogbo Sacred Grove and Agavaleae with its basic species Allizia Zygia. Families such as mimosoidaeae, euphorbiaaceae moraceae were encountered only at sampled sites in Osun Osogbo sacred grove and Margoba range and Tede range while Fabaceae was observed only but most abundant at OONP especially Margoba Range, Oyo Ile Range, Yemso Range, Tede Range and Sepeteri Range.

The implications of this analysis is that the two sites, Osun Osogbo grove and OONP significantly play key roles in conserving biological diversity with the two knowledge systems competed and contributing to *in situ* forest protection and preservation success in Southwestern Nigeria. Even though sacred groves were initially created to meet religious and socio-spiritual needs of indigenes, they are playing significant roles in *in situ* biodiversity conservation as evident from the network of different species and ecosystems present in local ecosystems in the grove. However, the belief systems, taboos and sanctions on which sacred groves were established are crumbling. Given the fast changing cultures, it is uncertain if these belief systems can be sustained.

The forest vegetation in the sacred grove is distinct in the sense that it is just about the remaining relic of the Nigerian rain forest ecosystem endemic to OOSG. The *in situ* forest functions as watersheds, protecting the water body and also accelerates micro climatic conditions within and communities adjoining the sacred grove. It is worth mentioning that the grove is rich in tropical diversity and this comprises trees, shrubs, herbs, undergrowth and climbers and some of the plants sacred to the local communities, Moreover, the forest houses primate species like white throated monkey (Guenon*cercoplhecus erythrogaster*), birds, snakes, and other repltiles, forest antelopes, squirrels and amphimbians. This result is compatible with that of Babalola in the same location [1]. Also there are wild water species including *Napoleona, vogelli, Aframomum danielli, Crinum jagas*, and *Denettia tripelata* among others which were prevalent in the grove.

CONCLUSION AND RECOMMENDATIONS

The sacred grove has a greater number of species present. However, the individuals in the community distributed more equitably among these species. In the OONP, where biodiversity conservation practices involved a scientific tool, findings indicate that about 17 fewer species and 70% of the individuals belong to one species. The result of the relative species density showed Osun Osogbo Sacred Grove have more species under conservation than OONP (3.14) with a biodiversity index of 3.48, suggesting a lower level of conservation compared to the grove; The two knowledge

system applications contribute to *in situ* biodiversity protection as evident in Osun Osogbo grove and OONP, and the use of natural resources, both plants and animal was done with respect to and guided by conservation requirements. This was evident from the results of species diversity index ranged from 3.14 to 3.48, and important value index ranging from 3.01 in OONP to as much as 8.27 in Osun Osogbo Sacred Grove. The rationale for sacred grove biodiversity conservation is quite different from the rationale for setting aside modern and scientific-managed national park.

Both indigenous and modern techniques of forest conservation encouraged the diversity of species. Species Diversity Index ranges from 3.27-3.48.This is an indication that the two methods contribute significantly to biodiversity intactness of the two study sites. This study discovered that the indigenous techniques in place to maintain Osun Osogbo Sacred grove contribute more to biodiversity conservation albeit the scientific methods in Old Oyo National Park network alone has not sufficiently address conservation issues.

To complement the role of the indigenous sacred forest biodiversity and habitat conservation, there is the need for integration of indigenous knowledge, practices and skills into modern knowledge based scientific methods of *in situ* biodiversity protection through local participation in conservation initiatives in order to develop sustainable preservation programmes. National Park Service, in collaboration with the Ministry of Education, should develop and initiate the process of educating people and creating awareness programmes targeted at children and the youths by stressing the direct and indirect values of forest resources and the scientific basis of indigenous conservation. This study suggests an integration of both indigenous and modern knowledge systems of biodiversity conservation into school curricula in Nigeria.

There is need for integration of reforestation programmes to attract wildlife and animal species to boost tourism. Therefore, future management of sacred forests must remain in the hands of indigenous people while the communities in the OONP must key in to community based conservation policy of the Park. Factors such as tourism, revenue and employment generation will play important roles in the future preservation of Osun Osogbo sacred grove and OONP and their biodiversity conservation potential.

The managements of the Osun Osogbo grove and OONP should also develop strategies for the promotion of domestication and preservation of economic and/or medicinal trees in the surrounding communities through creation of communal forests. This effort will encourage local people to harness other forms of biomass energy in order to reduce pressure on fuel wood from the *in situ* conservation.

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