

**COMPARATIVE ANALYSIS OF INDIGENOUS AND MODERN KNOWLEDGE
SYSTEM OF IN-SITU FOREST BIODIVERSITY CONSERVATION IN
SOUTHWESTERN NIGERIA**

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GEOGRAPHY**

CERTIFICATION

This is to certify that this research work was carried out by AJADI, Bolakale Saheed and had been read and approved as meeting the requirements of the Department of Geography and Environmental Management, Faculty of Social Sciences University of Ilorin for the award of Doctorate degree (Ph.D.) in Geography and Enviromental Management.

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DEDICATION

This thesis is dedicated to the Almighty God who made it possible for me to successfully complete this research work and to the memory of my late parents, Alhaji Usman AJADI and Hajia Halimat O. AJADI.

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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. This calls for an integration of indigenous conservation techniques with aspects of the modern techniques. The study is a comparative analysis of indigenous and modern methods of forest management in Southwestern, Nigeria. The objectives were to: (i) determine the level of adoption on indigenous and modern knowledge system of forest biodiversity conservation methods in the study area; (ii) assess the impact of indigenous and modern forest conservation; (iii) identify the factors affecting forest biodiversity conservation; and (iv) assess people's perception of the relative effectiveness of indigenous and modern methods of forest biodiversity conservation in the study area.

Primary and secondary data were used in this study. Primary data were collected through questionnaire administration and Focus Group Discussions (FGDs). 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 Grove (OOG) and Old Oyo National Park (OONP) records. Nine communities that fell within 0-10km around the OONP were randomly selected, while the four communities surrounding the OOG were sampled. In all, 539 copies of the questionnaire were administered. Quadrant method was used for sampling of the woody species. The study sites consisted of eight plots of 50 x 50 m along two 300m long transects. One Way ANOVA, Discriminant Analysis, 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 analyse the data.

The findings of the study were that:

- i) 96.1%, 97.5% and 90.9% of residents, stakeholders and staff, respectively supported the adoption of indigenous methods in OOG, while, 90.1%, 92.6% and 87.8 % of the residents, stakeholders and staff, supported the adoption of modern approaches in forest management in OONP;
- ii) biodiversity index was higher under indigenous conservation method at OOG of (3.48) compared to OONP (3.14) under modern conservation method;
- iii) factors affecting bio-diversity conservation in the two sites were fuel wood collection(19.60%),farming(21.50%),bush burning(17.83%), pastoralism (12.77%), deforestation(14.70%) and national policy governing the protected areas(13.60%);
- iv) 85% of the respondents viewed indigenous knowledge system as an effective conservation method; and

- v) 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 than modern techniques. The study recommended that indigenous conservation techniques should be given priority over modern techniques and where necessary both should be integrated.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Forest biodiversity is of important 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 (Ajibade 2007; UNESCO, 2014; Boon, Ahenken and Badian, 2009; Jimoh, Ikyaagba, Alarape, and Adeyemi, 2012; UNEP, 2012; Rim-Rukeh 2013).

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 (Jimoh *et al.*, 2012; Straku-Lartey, 2014). 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 (Warren, 1992; and IUCN, 2013).

Decline in biodiversity is increasingly becoming one of the major concerns of humankind since the last quarter of the 20th century (Hens, 2006; Berkes, 2010; Embo, 2015). In highlighting this view, the 2002 World Summit on Sustainable Development, held in Johannesburg - South Africa, 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 (Hens and Nath, 2003 cited by Hens, 2006).

Similarly, UNESCO (2010) 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 (Saches, 2015). 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 (Popoola, 2019).

Based on the above submissions, the following questions are raised: How does the difference in indigenous knowledge system and the modern approaches affect biodiversity conservation measures and local livelihoods? If there are distinctions, in what ways are the presence of these systems through the adopted techniques such as sacred groves and protected areas beneficial and detrimental to biodiversity conservation? What factors significantly affect the usefulness of sacred groves and conventional forest reserves in biodiversity conservation?

1.2 Statement of the Problem

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.

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.

The tropical rainforest zone of Nigeria is relatively small, accounting for only 9.7% of the country's land area of 983,213 km² 14.3% of the forest area of 234,004 km². Rain forests in Nigeria are under pressure and have showed signs of human activity even before colonial times (Adekunle, 2005; Onyekwelu and Olusola, 2014). Though there were evidence of forest conservation in Nigeria before the creation of forest reserves during the early 20th 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.

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. 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.

Throughout history, societies have developed conservation and management regimes which reflected the values they accorded forest biodiversity. The broad farsightedness for *in-situ* forest conservation recognizes that achieving and sustaining forest conservation also requires a variety of mechanisms which allow different forms and degrees of protection to be accorded to different forests through the establishment of areas protected from exploitation amidst the two knowledge systems; the modern and indigenous.

For numerous years, African societies have employed the knowledge of their local environments to sustain themselves and to preserve their cultural identity. It is only in the last few decades this knowledge been recognized by the western scientific community as a valuable source of environmental and social information. Currently, large quantities of information exist which demonstrate the existence of effective indigenous strategies for ensuring sustainable use of resources. Such information suggests that indigenous knowledge and its application like the modern knowledge system to an enlightened environmental assessment and management should be taken seriously as well. Nigeria is rich in both indigenous people and biological diversity.

The two systems appear to possess strengths and weaknesses, depending on the institutions that are handling them. Modern or the scientific techniques may be robust and sound in their drafting but may become weak at the stage of implementation whereas indigenous

knowledge may appear broad-based and all-inclusive, but its operations may be characterized by secrecy and cultural norms. This study examined both the indigenous and modern techniques in context in terms of their strengths and weaknesses with a view to finding a nexus for effective conservation practices for *in-situ* forest biodiversity, using the examples of sacred grove in Osun Osogbo and Old Oyo National Park.

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 (Tamino, 2014; Babalola, 2013; Onyekwelu and Olusola, 2014), 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.

Moreover, the effectiveness of both modern and local biodiversity conservation strategies is seldom assessed, and comparative assessment of effectiveness of the two conservation strategies, despite being complex and subjective, has been rarely attempted in Nigeria. In this study, comparative analysis of the contribution of indigenous sacred grove and the modern state managed forest resources conservation strategies, in harnessing biodiversity status are carried out.

1.3 Aim and Objectives of the Study

The aim of the study is to carry out a comparative analysis of modern and indigenous knowledge systems of biodiversity in sacred grove and national park, with a view to achieving sustainable forest management in Southwestern Nigeria. The specific objectives are to:

- (i) determine the level of adoption of indigenous and modern knowledge system of forest conservation in the study area;;
- (ii) assess the impact of indigenous and modern forest conservation;
- (iii) identify the factors affecting forest biodiversity conservation; and

- (iv) assess people's perception on the relative effectiveness of indigenous and modern methods of biodiversity conservation in the study area..

1.4 Justification for the Study

Several studies provide evidence on the existence of the indigenous worldview as characteristically rational, spiritual and mystical (Mokuku and Mokuku, 2004). However, the western worldview (scientific worldview) has been considering the traditional worldview as naive, superstitious and magical. For many local communities, the planet and its resources are considered sacred and deserve the utmost respect, and that is why management and conservation of these resources were based on and influenced by spiritual norms and constitutions (Steiner, 2004).

The study provides a new theoretical insight given the importance of sacred groves and national parks as vital tools for biodiversity conservation and contributory factors in environmental management. Presently, there are a few geographical studies on the analysis of indigenous and modern knowledge techniques through an indepth study of sacred groves and national parks in Nigeria. This study throws light on the traditional beliefs that help to conserve the groves and focuses on the biodiversity conservation observed among the local community.

Further, it is expected that the findings of the study will help policy makers to develop practical policies in order to detect, survey, protect and maintain sacred groves and improve on the national parks for the protection of forest biodiversity. The study similarly contributes to developing cultural based forest management programmes between the forest department and the chief priests and help the government to explore new groves that can be preserved and give attention to the groves that need reforestation and sustainability.

Increasingly, though there is a growing realization that indigenous knowledge reminiscent of modern knowledge system, has a crucial role to play in the preservation of forest biodiversity and the management of environmental resources. Finally, this study herein could form the nucleus of a research to further the conservation of tropical tree genetic resources. The research work could explore tropical species to develop strategies for conservation that also consider social and economic issues and needs, and to significantly improve the sustainability of natural forest in the sacred groves and national parks. This study, to some extent will further increase debate on the need for collaboration and integration of indigenous and modern knowledge systems for the protection, preservation and promotion of *in-situ* forest biodiversity.

With this study, Nigeria can make the most conscious and discernable efforts at *in-situ* forest conservation.

1.5 The Study Area

1.5.1 Oyo and Osun States

Southwestern region is one of the six geopolitical zones of Nigeria. It is located within latitudes $6^{\circ}45' - 8^{\circ}45'N$ and Longitudes $2^{\circ}50' - 5^{\circ}56'E$. The zone comprises six contiguous states namely Oyo, Osun, Ondo, Ogun, Ekiti and Lagos (Figure 1.1). 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.



Fig. 1.1 Southwestern, Nigeria

Source: Federal Survey Office, Ibadan (2017).

Oyo state is located between latitude 6°55'– 8°45'N and longitude 2°50'–3°56'E 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 sq mi) and has a population of 5,591,589 as at 2006 census (Wikipedia, 2012). Osun state is situated in the tropical rain forest zone. It covers an area of approximately 14,875 sq km and lies between latitude 7° 30' 0" N and longitude 4° 30' 0" E in the Southwestern Nigeria (See Fig.1.2).

Figure 1.2: Osun and Oyo States, Southwestern, Nigeria

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 9,251km². It is currently made up of 30 Local Government Areas spread across six main zones—

Osogbo, Ede, Iwo, Ikirun, Ilesha and Ile-Ife. Estimates in the recently released provisional figures of the 2006 census put Osun state human population at 4.137627million (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.

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 the state and dedicated to Osun goddess (See Figure 1.2). 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 (Wahab and Alarape, 2015).

1.5.2 Climate

Oyo state 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 1500 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 900mm 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.

Similarly, Osun State exhibits the typical tropical climate with prominent wet and dry seasons. The mean annual temperature is 21°C with daily temperature ranges between 24 °C and 35 °C. The rainy season generally occurs between April and October while the dry season occurs between November and March. The annual rainfall ranges from 1000 mm to 1600 mm. Mean annual rainfall is above 1000 mm and relative humidity is generally above 60 % during the day and not less than 70% in the night.

1.5.3. Vegetation and Soil

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 15m 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 km² (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:

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

Dominant tree species include *Azela Africana*, *Vitellaria Paradoxium*, *Annogeeissus Leiocarpus*, *Ceibapentandra*, *Bombax Spp* among others (Alarape, 2003; Onyekwelu and Olusola 2014). 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 (Filani and Alokun, 1993).

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 (*elaeis guineensis*) guinea and dense thickets (Filani and Alokun, 1993). The dense forest of the Osun grove was unique with distinct strata, and dominated with species which usually predominant towards or at climax level of the plants succession (Babalola, 2014).

1.5.4 Occupation

The favourable climate of Oyo State encourages about 70 percent of the inhabitants to engage in farming. They grow both permanent and food crops. Farmers in the state are predominantly small scale palm tree cultivators. Arable crops, such as maize, yam, cocoa, cassava, millet and rice are also cultivated for domestic consumption. Other occupations include industries such as the confectionaries, trading, hunting and civil service.

The predominant occupation in Oyo State is farming. About 70 percent of the population is engaged in agricultural activities. The State lies between the savannah area to the north and the forest areas of the South. As a result, there are both rainforest and savannah areas in the State. The fertile soils in the rain forest areas of the south and south - east are soils that support the cultivation of crops like cocoa, oil palm, kola nut and others, while the Woodland Savannah

areas of the west and north support the cultivation of food crops such as yams, maize and cash crops like cassava.

The production of industrial crops made the south and south eastern part of Oyo State to be attractive to colonial government and as a consequence became the first beneficiary of social and infrastructural facilities, such as roads, schools, health facilities, portable water, electricity etc. The savannah areas of the West and North (Northern Oyo; Oke-Ogun area) especially received little or no attention of the colonial administration in terms of socio—economic infrastructure. Oyo State is highly urbanized. The whole phenomenon of Yoruba urbanism has been clearly associated with the relative advanced social and political development of the Yoruba compared with other African people.

In both areas, wood products and non-wood products are gathered from the forest for various purposes, including supply of timber for poles, fuel wood, chewing stick, fruits, nuts, seeds, leafy vegetables, condiments, spices, oils, medicines and weaving materials. Other common activities in the areas include traditional hunting, livestock rearing, grazing, as well as other non-farming activities.

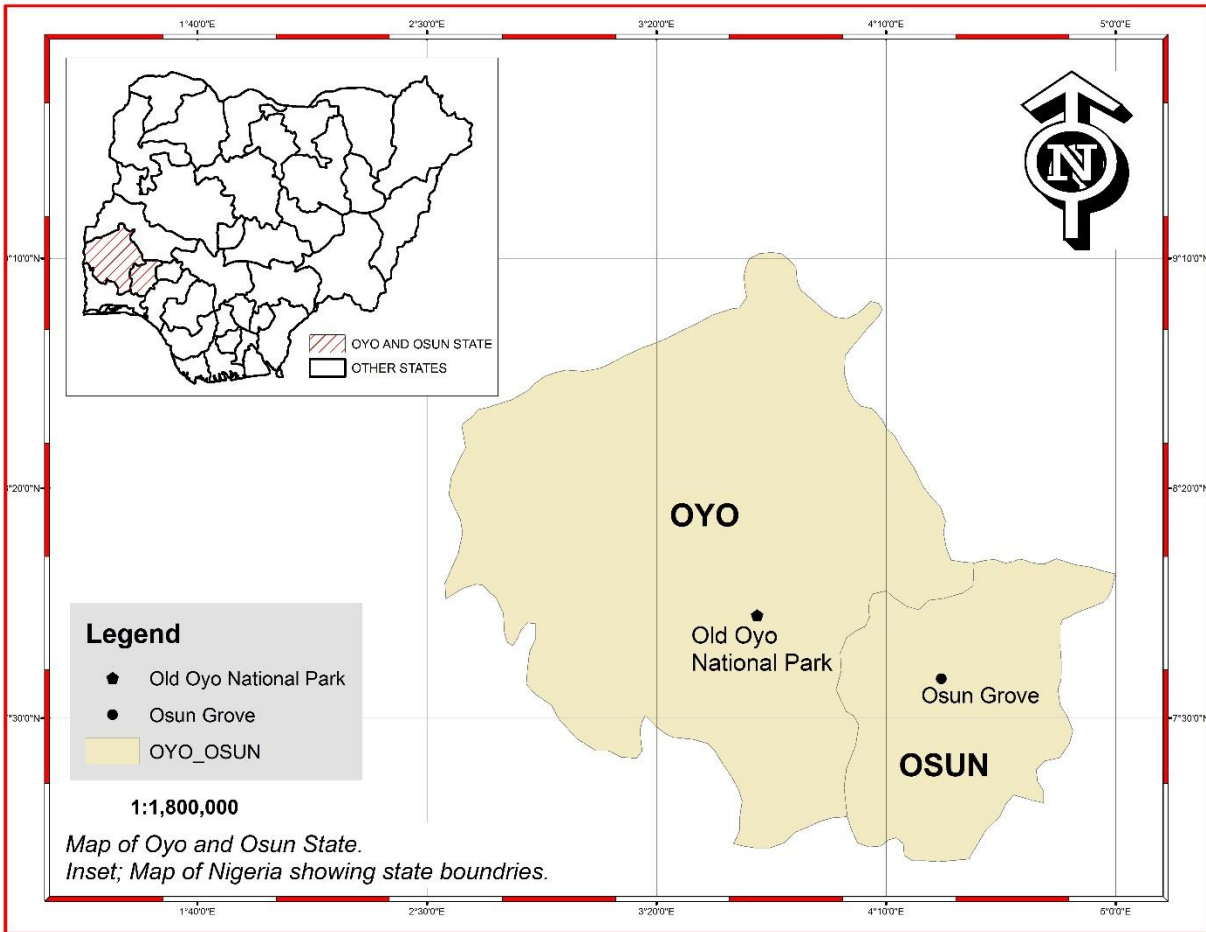


Figure 1.3: Map of the Study Area- Osun and Oyo States, Nigeria

Source: Office of the Surveyor-General of the Federation (2016).

The major occupation of Osun People is farming, both in export and food crops. The food crops produced are diverse, ranging from yams, rice, maize, beans and cassava to vegetables. The people predominantly engage in the practice of bush fallowing farming, except in areas around urban concentrations where combinations of farm yard manure and fertilizer permit continuous cultivation. Cocoa is the main export crop grown in the state. Besides farming, other human activities at the buffer zone of the ecosystem are hook and line fishing at the sacred river. Other activities include hunting, grazing, fuelwood harvesting and teaching.

1.5.5 Old Oyo National Park

The Old Oyo National Park is geographically located between latitudes $8^{\circ} 10'$ and $9^{\circ} 05'$ North, and longitudes $3^{\circ} 35'$ and $4^{\circ} 21'$ East, and centered on North latitude $8^{\circ} 36' 00''$ and East longitude $3^{\circ} 57' 05''$ (National Park Service, 2016). Whereas, Oyo state is located in the southwestern Nigeria. The Park is located between latitudes $6^{\circ} 55'$ and $8^{\circ} 45' N$ of the Equator, and longitudes $2^{\circ} 50'$ and $3^{\circ} 56'$.

The state shares boundaries with Ogun state in the south, Osun in the east, Kwara state in the north and an international boundary with Benin Republic along its western side (Figure, 1.4). The Park covers a land area of approximately $2,512 \text{ km}^2$ making it the fourth largest national park in Nigeria. Politically, it lies in Oyo State in the Southwest of Nigeria and borders Kwara State in the Northeast.

It is surrounded by ten (10) Local Government Areas in Oyo State namely: Atisbo (Tede/Ago-Are) $3.4220E, 8.5420N$, Atiba (Oyo) $(3.9260E, 7.8400N)$, Irepo (Kisi) $(3.8510E, 9.079N)$, Oorelope (Igboho) $(3.7550 E, 8.8340N)$, Saki East (Ago-Amodu) $(3.6100E, 8.6090N)$, Iseyin (Iseyin) $(3.5760E, 7.9590N)$, Orire (Ikoyi) $(4.1690E, 8.2700N)$, Itesiwaju (Otu) $(3.3970E, 8.2110N)$, Olorunsogo (Igbeti) $(4.1350E, 8.7450N)$, Saki West (Saki) $(3.3860E, 8.6620N)$ and Kaima Local Government Area in Kwara State. Figure 1 according to Kazeem (2015) shows the location of Old Oyo National Park and the adjoining communities (Figure 1.4).

There are three watersheds in Old Oyo National Park: River Ogun and its numerous tributaries, River Tessi and its tributaries and River Iwa and its tributaries. Ogun River flows southwards to the Atlantic Ocean. Several tributaries, notably Oopo, Iwawa, Oowe and Owu flow southwestwards and southeastwards, join it before its exit from the park. The Tessi River

flows northwards to the River Niger. Three main tributaries including River Soro join it before its exit from the park. The Iwa River flows northeastwards to the River Niger.

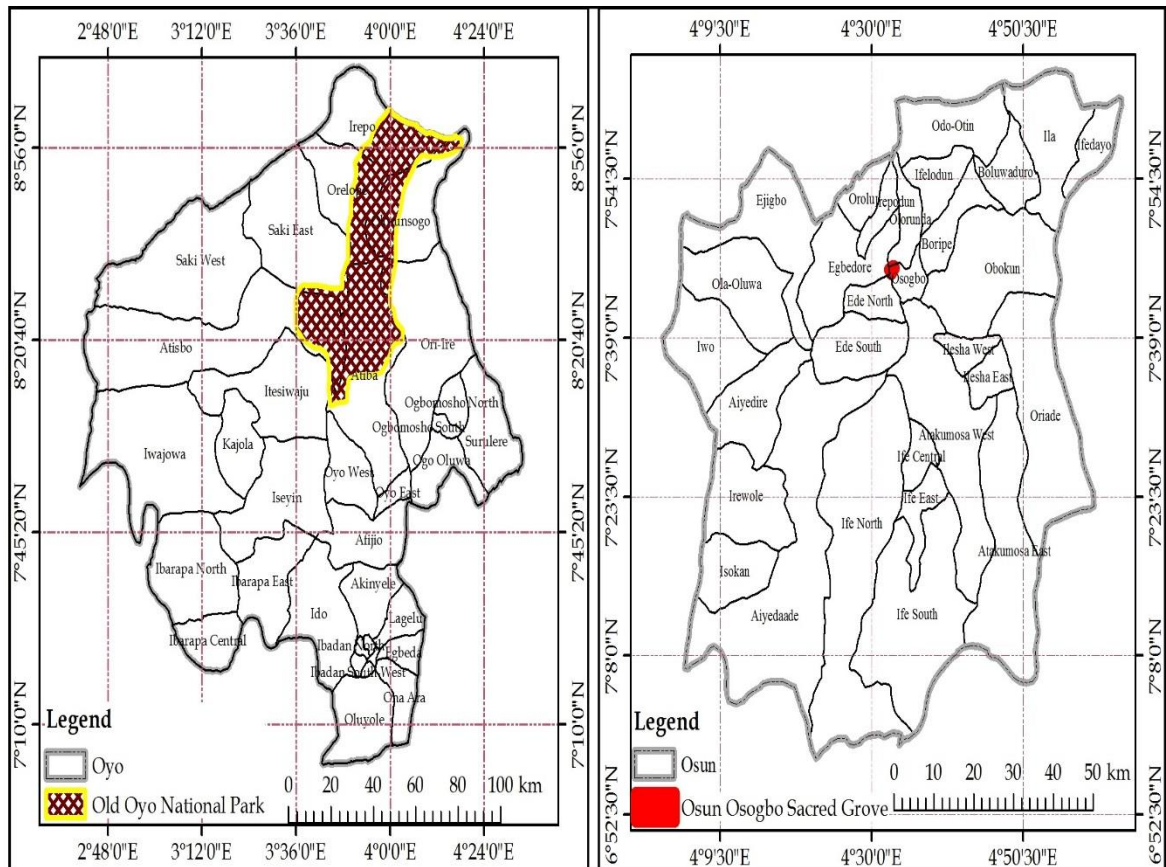


Figure 1.4: Location of Old Oyo National Park and Osun Grove in Southwestern, Nigeria

Source: Federal Survey Office, Ibadan (2017)

1.5.5.1 Flora of Old Oyo National Park

Vegetation of the OONP has been classified as Southern Guinea Savanna (Oladeji *et al.*, 2012). However more intense studies by Geerling (1973) classify the Southern portion of the vegetation as Forest Savanna Mosaic with wooded savanna containing relic of moist semi

Deciduous Forest, grading northwards into drier Mixed Leguminous Wooded Savanna with a continuous lower stratum of perennial grasses.

The vegetation was further analyzed and classified into four broad groups including Dense woodland and Forest outlier in the Southern portion and the North West corner, mixed open savanna in the middle and North east portions, Outcrop vegetation in the hilly and rocky areas and Riparian grassland and fringing woodland and forest vary along major rivers and streams dominated.

The team of experts working on the management plan of the Park described and recognizes four broad ecozones to include forest and dense Savanna Mosaic Woodland of the Park around Sepeteri axis designated as site A, dense and open Savanna Woodland Mosaic in the central portion of the park, Dense Savanna Woodland, north of Igbeti-Kishi axis zone C and Open Savanna Woodland, north-east of the park (Oyo-Ile sector) (Afolayan *et al.*, 1997).

1.5.5.2 Fauna of Old Oyo National Park

Animals like Lion, Leopard, Greater bustard, Spotted hyeana, Serval cat, Aadvark, Elephant, Buffalo, Kob, Waterbuck, Reed buck, Oribi, Roan antelope, Hartebeest Bush buck, Spotted Hyena, Common Warthog, Red River Hog, Red flanked Duiker, Bush Buck, Mongoose, Maxwell's Duiker, Patas Monkey, Tantallus Monkey, Olive Baboon, Hunting dog and Mangabey were sighted in the OONP (Petrides 1962; Ayedele,1988; Alarape, 2002).Therefore,OONP is endowed with fauna and flora resources that have been preserved and conserved over a long period of time (Oladeji and Agbelusi,2014).

1.5.6. Osun Osogbo Grove

Osun Osogbo grove is in the Southwestern region of Nigeria where the Yoruba people are the predominant group and one of the two internationally-recognised ecological

environments (Sacred Sites) under the convention on preservation of cultural and natural sites (UNESCO Convention) because of its importance as a cultural and natural resources enrichment (NCMM, 2015; Wahab and Alarape,2017).

The grove covers an area of 75 hectares and it is a typical example of a true primary rainforest that is fast disappearing in the West African Sub region and one of the few vestiges of the rainforests in Nigeria. The grove is fenced with a 4 Kilometers chain link or wall in areas where land pressure exists. It has a buffer zone of about 47 hectares surrounding the grove (See Fig. 1.5).

Groves and shrines are believed to be the dwelling places for deities and spirits. In Nigeria, there are numerous examples of local shrines that have been points of attractions for adherents and admirers. The two prominent centres worthy of mention are the Omo - Ukwu temple in Ohaofia and Osun shrines at Osogbo (Okpoko, 2001).

The Osun -Osogbo Grove is among the last of the sacred forests which usually adjoined the edges of most Yoruba cities before extensive urbanization (Babalola, 2014). The landscape of the grove and its meandering river is dotted with sanctuaries and shrines, sculptures and art works in honour of Osun deity. Set within the forest sanctuary are forty shrines, sculptures and art works erected in honour of Osun, a Yoruba deity, two palaces, five sacred places and nine worship points strung along the river banks for designated priests and priestesses (NCMM,2007).

The grove has a mature, reasonably undisturbed, forest canopy, which supports a rich and diverse flora and fauna including the endangered white-throated monkey. The grove is an active religious site where daily, weekly and monthly worship takes place. More importantly, an annual processional festival to re-establish the mystic bonds between the goddess and the people of the

town occurs every year over twelve days between July and August and thus sustains the living cultural traditions of the Yoruba people.

The Grove is also a natural herbal pharmacy containing over 400 species of plants, some endemic, of which more than 200 species are known for their medicinal uses (Olaniyi, 2011). The Osun is acclaimed as the goddess of fertility, prosperity and healing. Despite the proximity of the forest to human habitation, the grove was traditionally maintained and protected by the indigenous people using myths and belief system. These prevent any form of encroachment regarded as sacrilegious and offensive to the goddess.

The Grove was first declared a National Monument by the Federal Government of Nigeria in 1965. The original designation was amended and expanded in 1992 to protect the entire 75 hectares. Osun grove was recognized by UNESCO in 2005 as a world heritage site, and this has been linked to the consistence that the festival has enjoyed over the years and the protection of the values of the grove by the people.

Speaking at an event on what has helped to preserve the Osun Osogbo heritage in the face of the threat of civilization, the coordinator of the National Museum, who is directly in charge of the grove, explained that it has to do with consistency. According to him, “the reason why UNESCO recognized Osun Osogbo sacred grove, inclusive of the festival, is because of the authenticity that is involved. It is the only festival that, since 1370 AD, has remained what it was originally despite modernity. There has not been any adulteration, everything has been in its original state, and all the structures that were put in place that form the foundation of Osun Osogbo kingdom are still in existence in the grove (UICN,2015).

Osun -Osogbo Sacred Grove is also part of National Tourism Development Master Plan that was established with World Tourism Organization (WTO) and United Nations Development

Program (UNDP). Tayler (1999) stated that the annual Osun Osogbo festival will need to be better managed so that the site will no longer suffer from adverse impacts of tourism during the festival. The Grove will also serve as a model of African heritage that preserves the tangible and intangible values of the Osogbo people in particular, and the entire Yoruba people. Olatunbosun (2012) opined that the Grove will remain a living thriving heritage that has traditional landmarks and a veritable means of transfer of traditional religion, and indigenous knowledge systems to African people living at home and in the diaspora.

1.6 Scope of the Study

This study analysed indigenous and modern knowledge systems in Southwest Nigeria specifically in Oyo and Osun States. The study will particularly focus on forest biodiversity onservation in two proposed areas in southwest which are Old Oyo National park (OONP), Oyo and Osun Grove, Osogbo. The selection of these forest biodiversity areas is based on their high rate of biodiversity status, conservation priority and vegetation disparities. For the purpose of spatial comparison, the study will be limited to two forest biodiversity sites in each of the selected areas which involve both indigeneous and modern knowledge methods of forest biodiversity conservation.

CHAPTER TWO

LITERATURE REVIEW

2.0 CONCEPTUAL ISSUES, THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1 Conceptual Framework

2.1 .1 Ecology

The basic elements of plausible definitions to explain large scale patterns of species richness in terms of ecology and conservation of natural resources have been mentioned by several pervasive prominent scholars. Ecology was originally defined in the mid-19th century by Ernst Haeckel as "the study of the relationships of organisms with their environment". About one and a half century later, other definitions of ecology were proposed reflecting, the growth of the discipline, finding new specialties, and marking out disciplinary territory.

There are three definitions of ecology. The first definition stems from the Haeckelian form by Egerton (2013) as the study of the relationship between organisms and environment. The second, which is perhaps the most common, considers ecology to be the study of the distribution and abundance of organisms (Andrewartha and Birch 1954). The third definition sees ecology as the study of ecosystems (Odum, 1971). These new all-embracing definitions attempt to bridge the spectrum of approaches to the concept of ecology.

Ecology has been variously defined as a science that focuses on interactions between living organisms and their environment, in particular and the factors that influence their abundance and distributions. It is a science that attempts to show the relationship between plants and animals and the environments in which they live, how they live there and why they live there and their interactions with their habitat or environment (Jeje and Adesina 1996; Odum 1983; Shant 2014; Chindra 2010), ecology encompasses the study of the interaction between organisms

and their environment. Environment includes physical attributes such as temperature, water and wind (abiotic) environment and the biotic elements of the environment such as vegetation, animals and microorganisms (Qusthtoch,2014).

Ecology describes the environment as it relates to living organisms. Ecological diversity is the complex network of different species present in local ecosystems and the dynamic interplay between them (Cardinale, 2000; Burney, 2005; Balvanera,2006; Rabosky,2009). The diversity of species and genes in ecological communities affects the functioning of these communities (Shant,2014).

This implies that ecology is the scientific study of the processes influencing the distribution and abundance of organisms, the interactions among organisms, and the interactions between organisms and the transformation of energy and flux of matter. Generally, ecology centres on the joint consideration of both biotic and abiotic aspects of nature. Depending on the ecological specialty, the focus can be on different proportions of biotic or abiotic aspects of nature (American Wildlife, 2015).

The relationships between organisms and the physical world can be bidirectional, although different specialties may emphasize the effects of the organisms (and systems containing them) on the physical world, or the effect of the physical world on the organisms. The boundary between the abiotic and the biotic aspects of ecology is blurry, hence, the disciplinary focus is on "processes", "interactions" and "relations" rather than on the physical entities per se (Odum, 1971, Chindra, 2010). Parnes *et al.* (1998) identifies two approaches to studying ecology namely: the vertical approach and horizontal approach. Whereas the vertical approach focuses on how ecosystems function (e.g determining how and why carbon, water and nitrogen cycles change in response to fire) the horizontal approach focuses on the study of the spatial

arrangements and interactions between and among ecosystems. With the horizontal approach, one can identify, map and compare ecosystems across landscapes.

Ecological processes operate at different temporal and spatial scales which are concerned with the study of landscape, their heterogeneity or dissimilarity or diversity of the components or elements of a landscape in both space and time, and how these ecological constituents operate as a system. As a field of scientific inquiry, ecology constitutes the development and maintenance of spatial heterogeneity, interaction and exchanges across heterogeneous landscapes.

The influence on biotic and abiotic processes and the management of landscape heterogeneity are parts of the salient characteristics of landscape entity and its emphasis on the relationship among patterns, processes and scale. From all indications, ecological landscape focuses on the study of spatially heterogeneous areas, fluxes and redistributions of materials and energy across landscape elements and human actions responses to, and their reciprocal influence on ecological processes in the environment (Shant, 2014; Conservation Ecology, 2015).

The subject matter of ecology is normally divided into four broad categories. Physical ecology, is concerned with the response of single specie environmental conditions such as temperature or light. Population ecology focuses on the abundance and distribution of individual species and the factors that cause such distribution. Community ecology, focuses on the number of species found at a given location and their interactions. Ecosystems ecology, is concerned with the structures and functions of the entire suite of microbes, plants, and animals, their abiotic environment and how the parts interact to generate the whole. This branch of ecology often focuses on the ecology and nutrient flows of ecosystems. When this approach is combined with computer analysis and simulations, it is often referred to as systems ecology (David, 2013).

In essence, ecology deals with the study of complex systems. A complex entity according to Fogelman (1992) and Gell-Mann (1994) is composed of different elements that interact and compare in a way that may not be obvious at first. The complexity of the systems is in the eye of the observer. The idea that the concept of complexity is inseparable from perception is not natural but depends on the scale of observation of the system under study. In ecology, there is no scale for observing all phenomena. Conventionally, the hierarchy of scales (Allen and Starr, 1982) refers to organizational levels in ecology namely: cell, organism, population, community, ecosystem, landscape, biome and biosphere.

A basic principle of the hierarchy theory concerns how higher levels of organization act to constrain lower levels. Each level is composed of the subsystems on the next lower level and is controlled by the level above it. The hierarchy of these eight levels is often presented as a straight tower, but there is not necessarily a time- or space-dependent difference between the classes. These ecological levels of organization are not scale-dependent, but are criteria for telling foreground from background, or the object from its context (Allen and Hoekstra, 1990).

One of the major issues in ecology is the ability to take into account the multiplicity of scales of study so that each of the phenomena at the level of their species can be integrated during a phase called “scale transfer”. For example, one of the common and relevant problems that occur in managing renewable natural resources estimating the risk of extinction of a species as a function of space fragmentation (Ayodele, 1988)

.According to Hall (2014) ecology is usually viewed from the perspective of the specific geographic environment that is being studied at a particular moment. These environments include the tropical rainforest, temperate grassland, arctic, tundra, the entire biosphere, and so on. The subject matter of ecology is the entire natural world, including both the living and the non-living

parts. Biogeography focuses on the observed contributions of plants and animals and the reasons for the contributions. More recently ecology has included the increasingly human-dominated world of agriculture, growing lands for domestic animals, cities industrial parks and constructions.

From these perspectives, there are four basic reasons for the need to want to urgently understand ecology. First, the need to understand the environment around us, with a better understanding of nature. Secondly, human economics is based on the exploitation and management of nature (forest, fisheries, agriculture, range management and so on). Thirdly, human societies are often understood very clearly from an ecological perspective as we study, for example, the population dynamics (demography) of our own species, the food and fossil energy flowing through our society. Fourthly, human appears to bring changing aspects of global environments in many ways.

Ecology can be very useful to help us understand what these changes are, what the implications might be for various ecosystems, and how we might intervene in either human economics or in nature to mitigate (conserve) or use either, through understanding, predicting and adapting. Since these ecological issues could be the most important of all possible issues for human to deal with, the focus of these reviews is conservation ecology (Dickson, 1999; Hall, 2014; Boerer, 2011; IAS, 2014).

Boerer (2011) stresses that ecology relies heavily on looking at cause/ effect relationship within the ecosystem; by understanding the effects human beings have on their surroundings. The focus of conservation ecology is man's impact on the environment (Morame, 1984, Taylor 1984). For example, Ayobami and Orimoogunje (2011); Padoch (1992); UNESCO-ICSU;(1999); Belcher and Kesters (2004); Biodiversity Initiatives (2014); EMBO (2008) among

others stressed the potentials of conservation of forest resources, biodiversity and other natural resources. These ecological effects of biodiversity in turn affect both climate change through enhanced greenhouse gases, aerosols and loss of land cover (Nelson *et al.*, 2000; Hooper *et al.*, 2005) and biological diversity, causing a rapid loss of ecosystems and extinctions of species and local populations. The current rate of extinction is sometimes considered mass extinction, with current species extinction rates on the order of 100 to 1000 times as high as in the past (Pimm *et al.*, 2000; Biodiversity Initiatives, 2014).

2.1.2 Ecosystems

The term ‘‘ecological system’’ represents an approach to the study of organisms either artificially in the laboratory, or where they normally live. The study takes into account the all-embracing nature of the processes going on in the biosphere. This includes the lowest and simplest of animals in the laboratory to the great Amazonian rain forest and even to the earth itself. Jeje and Adesina, 1996; Odum 1993 quote two concise and comprehensive definitions of the term ecosystem.

An ecosystem is a dynamic complex environment, where there is a regulated transfer of energy and a controlled cycling of nutrients, the plants, animal and micro-organism and the non-living objects in the same environment interacting as a functional unit. Ecosystem is the planet’s support system for the human species and all forms of life (Millennium Ecosystem Assessment, 2005; John *et al.*, 2012; Johnson, 2013). The definition by Odum (1985) ‘‘Ecosystems are complex systems comprising organisms, the physical environment and their interactions’’ appears to be clearer than the definition by Chapz *et al.* (2014) ‘‘Whatever the size, an ecosystem operates as a unit both in its abiotic and biotic parts including their functions’’. Chapz *et al.* gives a narrower definition. There are still many divergent definitions of ecosystems. Out of the whole,

the definition of Odum is being adopted. It is broad and clearer and integrates other narrower definitions.

Forces of ecosystems occur on many scales and must have been influenced by human actions in one way or another. Approaches to ecosystem should include mechanistic (process oriented, empirical and model based investigations that address composition (i.e the type of species present), structure (the arrangements of species in space), and functions (energy flow and matter cycling). Each of these influences the property of the other and both are necessary for maintenance of life. The flow of energy and materials through organisms and the physical environments provides a framework for understanding the diversity of forms and functioning of both physical and biological processes.

Ecosystem ecology comprises organisms and their physical environment and the interaction between organisms and their physical environments (Odum, 1985; Shant, 2014; Chindra, 2015). The urgent concern for the loss of old growth forest habitat and endangered species led to the development of ecosystem management in the 90s. It addressed the multiple functions and uses of forest resources and other resources on the earth (Christensen *et al.*, 1996; Jeje *et al.*, 1996).

Ecosystem analysts seek to understand the factors that regulate the pools (quantities) and fluxes (flow) of materials and energy through ecological systems. These materials include carbon, water, nitrogen, rock –derived materials such as phosphorus and other chemicals. These materials are found in abiotic (non-biological) environment such as soils, rocks, water and the atmosphere and in biotic pools such as plants, animals and soil micro-organisms (Chapz *et al.*, 2014).

The study of ecology encompasses many objects such as an individual cell of the ecosphere, individual population, communities, ecosystems and landscapes. Ecosystems with a large biodiversity of species, such as rainforests, are stable and resistant to change, unlike ecosystems with low biodiversity. The “individual – environment- population” system, which is at the heart of ecological trough, according to Odum (1985) presents a multitude of intertwined interactions which can be formed into one or two categories between organisms (competition, predation,etc.) and interactions between organisms and their physical environment (the environment “conditions”).

The examination of how humans impact on or modify plant and animal communities comprises one of the key foci of biogeography which is concerned with the study of how humans have impacted on the integrity, composition or ecological synergism in plant and animal communities. The emphasis is either on the cultural significance of plant and animal uses or on the modification of plants and animals as a consequence of human interactions.

There are many components that are connected to each other as food chain. These components are for life-energy, water, carbon, air and nutrients in a series of connections and process. An ecosystem is a self-sustaining and self -regulating community of living organisms and its non-living environment. Ecosystems are dominated by trees that can mature to at least 2 meters in height and provide a canopy of at least 20% over, together with all the native wildlife, including birds, mammals, marsupials, amphibians, reptiles, insects, plants as well as moss, fungi,micro-organisms and non-living things such as water, soil, and air interacting within the same area.

There is a consensus among scholars that ecosystems are critical to the long-term sustainability of ecological communities which are a necessary level of biodiversity, long-term

availability of life-supporting abiotic process and systems. They sustained long-term natural ecological processes within the ecological systems in which the ecological communities reside and from which they obtain their sustenance. These are often a prerequisite for a high level of resistance to perturbation, along with the ability (resilience) to return to a state of equilibrium after perturbation, which may not necessarily be the exact pre-perturbation state of equilibrium (Holling 1995; Parker and Pickett 1997; Levin 1999; Holling and Gunderson 2002; Earth Watch, 2015).

While within an ecological community species diversity is readily observable, providing insight into an ecological community's biodiversity and its structure, the functional aspects of biodiversity remain only vaguely defined (Martinez 1996). However, there is recognition that biodiversity has an influence on the interactions between organisms and ecological processes, such as between material and energy flow through. There is also recognition that in a diverse ecological self-organizing assembly of species, the whole is greater than the sum of its parts (Levin 1999).

2.1.3 Conservation

Conservation is the preservation and careful management of natural resources -living and non-living. Conservation involves all the processes and sections of looking after an area so as to retain its natural significance and this includes the protection of biodiversity and wellbeing of ecosystem functions.as well as non-living things in that area. It is the exploitation, improvement and protection of human and natural resources in a wise manner, ensuring derivation of their highest economic and social benefits on a continuing or long-term basis (IUCN, 2013; Begon *et al.*, 1990).

According to Earth Watch (2015), conservation is the production, preservation, management, restoration of wildlife and natural resources such as forest and water. Through the conservation of biodiversity, the survival of many species and habitats which are due to human activities can be ensured. Other reasons for conserving biodiversity include securing valuable natural resources for future generation and protecting the wellbeing of the ecosystem functions. In recent times, according to EMBO (2008) humans and human activities have contributed to the extinction of many species of plants and animals and the rate of extinction is now considered to be well above the rate of natural extinction.

There are many reasons that can influence the status of plants and animals. These include collecting, hunting and animal trade. However, the main cause of conservation is destruction of habitats. Once a species has become miserable, almost any level of environmental change or disturbance can affect its status. For example, environmental changes or disturbance can result in a reduction in suitable shelter, a reduction in suitable breeding sites, a reduction in food supply, an increase in predator's competition, unpredictable events such as fire, flood, and drought which can pose serious threats to the survival of the world (UICN.2004; EMBO 2008; Biological Sciences, 2014; Earthwatch, 2015).

Another important reason that has been attributed to loss of biodiversity is the replacement of natural old growth forests with a monoculture of an exotic species which greatly reduces forest biodiversity (Oriola and Omofoyewa, 2016).

Conservation cannot be concluded in isolation from humans and for conservation to be successful and sustainable; there is the need to involve local communities. In other areas of the world, local people are involved in conservation efforts and development priorities of local communities must be taken into account, if that conservation measures are to be sustainable.

According to IUCN (2015) many of the world's ecosystems have undergone significant degradation with negative impacts on biological diversity and peoples' livelihood.

There is now a growing realization that the world will not be able to conserve the earth's biological diversity through the protection of critical areas alone. It is based on the principle that environmental problems are beyond the conventional limits of the physical and ecological aspects of the ecosystems, but also on the economic and social factors.

2.1.4 *in-Situ* Conservation

in-situ conservation involves the conservation of species in their natural habitats, especially in places where the species normally occurs and is being considered the most appropriate way of conserving biodiversity (Gant *et al.*, 1994; Asthana and Asthana, 2012). It was further stressed that conserving the areas where populations of species exist naturally is an underlying condition for the conservation of biodiversity. That is why protected areas form a central element of any national strategy to conserve biodiversity or the entire ecosystem. In an *in-situ* conservation the natural surroundings or the entire ecosystem is protected and maintained so that all the constituent species, known to us are conserved and benefited.

Consequently, factors which are detrimental to the existence of species concerned are eliminated and the rest is left to the nature which takes care of its own self. The strategy of *in-situ* biodiversity conservation revolves around establishment of small or large protected areas which are set aside exclusively for floral and faunal resources. Human activities such as , hunting, firewood collection, timber harvesting etc. are restricted in these areas so that wild plants and animals could grow and multiply in a protected area.

According to Asthana and Asthana, (2012); IUCN,(2015); WWF, (2015) the *in-situ* strategy though not adequate or fully successful has been of much help in preserving a

considerable variety of life forms .Today, there are about 7,000 protected areas, parks and sanctuaries , nature reserves worldwide which cover more than 650 million hectares of earth's surface representing about 5% of the total area. These varieties differ from one another in their sizes, purpose and the degree of human interference or management efforts accorded(UICN, 2015).

2.1.5 Biodiversity and Biodiversity Conservation

Biodiversity means the varieties of life on the earth surface. Biodiversity refers to the variations which exist in living organisms and the range of habitats they live in. Variations exist between and within ecosystems, as well as between and within species. From a survival point of view, these variations are extremely important. It can be studied on many levels. At the highest level, one can look at all the different species on the entire earth.

On a much smaller scale, one can study biodiversity within a pond ecosystems or a neighborhood park. Identifying and understanding the relationships between all life forms on earth are some of the greatest challenges in science. Biodiversity includes the full range of species that live in an area (Biological Sciences 2014, IUCN, 2015). United Nations Earth Summit in Rio de Janeiro described biodiversity as the variability among living organisms from all sources including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part. These include diversity within species, between species and of ecosystems.

Biodiversity is generally described at three levels: genetic diversity, species diversity and ecosystem diversity. All life forms that make up biodiversity, including humans, are ultimately connected to all other forms of life and to their physical environment. Elements of any ecosystem are independent of one another. Connections among living and non-living elements keep the

environment functioning and healthy because biodiversity represents the interconnectedness of all things, on the earth surface. Human impact on the environment, therefore, directly or indirectly affects the functions of other living things, and, by extension, ourselves (Laird and Pither, 2003; Aarssen *et al.*, 2009).

Some of the values of biodiversity as opined by Shanter (2014) include evolutionary, ecological, economic, social, cultural, and intrinsic values. Biodiversity is nature's insurance policy – the more varieties there are now, the more there can be in the future, and the greater the chances of adapting to major changes in environmental conditions. Biologically, diverse ecosystems offer a variety of natural products, including medical ingredients that enhance human health and standards of living. Biodiversity provides ecosystem services: water purification; clean air, fertile soil, climate regulation, flood control as well as pest regulation and disease resistance, essentially for the cost of letting natural systems function (IAS, 1997; Schmütz, 2007).

Hence, sustaining biodiversity has economic benefits: world ecosystem services reliance on biodiversity is valued at 33 trillion dollars per annum while the total of all economic goods and services is valued at 18 trillion dollars per annum. Biological diversity is key to long term ecosystem sustainability (e.g. 75% of cash crops rely on a variety of insects and other organisms for pollination; a biologically diverse agricultural ecosystem provides stability, nutrients to the soil and natural pest resistance). Biodiversity is key to sustaining the natural beauty of National and Provincial Parks and green spaces for recreational use and heritage preservation (Biological Sciences, 2009).

There is a growing scientific concern about the major rapid decline in biodiversity around the world. The extinction of each additional species and the loss of variation within species bring the irreversible loss of unique genetic diversity. The scientific community has linked human

activities to the accelerated rate of recent and current extinctions. Biodiversity is declining because of habitat loss, invasive species pollution, population growth, over-consumption (Unsustainable use), and climate change etc causes.

The report of the Convention on Biological diversity (2010) revealed that most indicators of the state of biodiversity show negative trends, with no significant reduction in the rate of decline (Global Biodiversity Outlook, 2010). Biodiversity resources are natural resources which replenish themselves to overcome resource depletion caused by usage and consumption, either through biological reproduction or other natural recurring processes in a finite temporal and spatial scale.

IUCN (2008), notes that the human cultural diversity and biodiversity are linked. In fact, indigenous cultures and living traditional lifestyles require an intact and functioning ecosystem, which is threatened by the loss of biodiversity and attendant ecosystem goods and services. Human impacts on biodiversity have been accelerating as population growth and consumption rates have increased. Extinction is a natural part of life on Earth.

Over the history of the planet, most of the species that ever existed, evolved and then gradually become extinct. Species go extinct because of natural shifts in the environment that take place over long periods of time, such as ice ages. Today, species are going extinct at an accelerated and dangerous rate, because of non-natural environmental changes caused by human activities. Some of the activities have direct effects on species and ecosystems. Such effects include habitat loss and degradation, over exploitation of ecosystem resources (such as overfishing), spread of non-native species and diseases.

Some human activities have indirect but wide-reaching effects on biodiversity. These activities include; climate change, pollution, urbanisation, agricultural practices, animal

grazing,mining activities,infrastructural development,lumbering and forest clearing, dam construction and hunting among others (Biological Sciences Report,2013).All of these threats have put a serious strain on the diversity of species on Earth.

According to the International Union for Conservation of Nature (IUCN) (2008), globally about one third of all known species are threatened by extinction. These include 29% of all amphibians, 21% of all mammals and 12% of all birds. If we do not stop the threats to biodiversity, we could be facing another mass extinction of these species with dire consequences on the environment, human health and livelihood. Habitat destruction is doing more damage to biodiversity than any other human activity. If natural ecosystems are conserved, a variety of habitants can be saved.This will protect endangered species from extinction (IUCN, 2008).

However, biodiversity conservation is perceived as abundance and number of different species of plants, animals and the non-living organisms, in a given geographical area, living in spiritual and reciprocal relationships between the living and the non-living things,whereas humans are perceived as part and parcel of the supporting ecosystem (Ruheza *et al.*, 2012).There has been insufficient integration of biodiversity issues into broader policies, strategies and programmes and the underlying drivers of biodiversity loss have not been addressed significantly.

Actions to promote biodiversity receive a tiny fraction of funding compared to industrial development drivers of biodiversity loss, including demographic, economic, technological, socio-political and cultural pressures, in meaningful ways, have also been limited.Furthermore, biodiversity considerations are often ignored when such developments actions to address the underlying issues are raised (Gaston,2000; Lodge *et al.*,2005; Hassan,2006).

The Convention on Biological Diversity (CBD) was born at the 1992 UN Conference on Environment and Development (the Earth Summit). 192 countries, plus the EU, are now parties to that convention. In April 2002, the Parties to the Convention committed itself to significantly reduce the loss of biodiversity by 2010. As the Global Biodiversity Outlook report summarizes; the dream couldn't come through despite numerous successful conservation measures supporting biodiversity. The 2010 biodiversity target has not been met at the global level.

None of the twenty-one sub-targets accompanying the overall target of significantly reducing the rate of biodiversity loss by 2010 cannot be said to have been definitively achieved. Despite an increase in conservation efforts, the state of biodiversity continues to decline. There is no indication of a significant reduction in the rate of decline in biodiversity, nor of a significant reduction in pressures upon it (Cardinal *et al.*, 2000; Zavaleta *et al.*, 2006). There is, thus, the need that biodiversity resources are managed in sustainable manners for the present and future generations (Popoola, 2018; Ruheza, 2012; Tamino, 2014).

2.1.6 Sacred Groves

Generally, sacred forest is seen as a place populated by several types of supernatural beings; deities which may look human. They differ by their supernatural powers and immortality. It is also believed that the spirits of the ancestors also live in the forest (Aumeeruddy and Bakels, 1992). A sacred grove is a forest in which villagers perform some rituals to communicate with the spirits and ancestors. In Benin, except for the mystic club forests (Oro, Kouvito and Zangbeto) which are wholly forbidden for the non-initiated, sacred groves provide many useful goods such as hardwood and poles, fuelwood, medicine, vegetables and edible fruits (Babalola, 2014; Kokou, 1997),

The fuel woods consist of old dead wood collected by women. Edible fruits are collected by everyone who goes into the forest (women, men, children, hunters) and women often collect leaves for wrapping meals (leaves of *Thalia welwitschii*, *Cola gigantea*, e.g.) Roots, barks, fruits and leaves of many plants are used as sources of medicine by many local people (Oyelowo *et al.*; Agbo *et al.*, 1993) .

A sacred grove is described as a patch of vegetation ranging in extent from a few trees to forty hectares or more, which is left undisturbed because of its association with some deity. In its original form, this protection forbade any interference with the biota of the grove whatever, and not even a leaf litter was removed from it, nor was grazing or hunting permitted within the grove (Gadgel and Vartek, 2002). Even when the protection has become less stringent, any removal of live wood continues to be taboo. The groves therefore represent a sample of the vegetation in its climax state. This therefore implies that sacred groves are tracts of sacred forests which have been completely or nearly completely immune from human interference on grounds of religious beliefs (Hughes and Chandran, 1998). \

A patch of forested land, maybe small or large, dedicated to a local deity or deities, generally believed to be fierce, left untouched by the local people for socio – religious reasons. This patch may have rare trees, medicinal plants and endemic species of birds or animals. Such patches, in their pristine conditions, which the local people want to conserve, contribute immensely to the bio diversity of the nation.

Sacred groves vary in size from a few hectares to a few kilometers. Protected by local communities as being the sacred residences of local deities and sites for religio-cultural rituals, they have served as valuable storehouses for biodiversity. Sacred groves are forests that have been protected since the ages by traditional societies. In the past, sacred groves were present in

numerous parts of the world on nearly every continent, and were entities held sacred by communities with different religions and different forms of economic and social organization. Most of the world's sacred groves have disappeared and few remain today (Gadgil and Vartak, 2002; Anup, 2006; and Oyelowo *et.al.* 2014).

The concept of 'sacred' species provides a basis not only for natural resource management, but also for rehabilitation of degraded ecosystems with community participation. Thus, a system of incentives needs to be worked into the system to reward communities for conserving sacred groves. Sacred groves perform useful environmental tasks, not merely for the immediate vicinity but for a much larger audience (Anup, 2006). Though sacred groves were originally established for spiritual, cultural and worship purposes, they have greatly contributed to in-situ biodiversity conservation such that today, they are noted to represent biodiversity hotspots (Myers *et al.*, 2000) and are considered as refuge for endangered species. The importance of sacred groves as a tool for biodiversity conservation is hinged on widespread distribution and their important roles as reservoirs of local biodiversity of threatened species (Laired, 1999).

In many local communities in Africa, there is often a huge tree or a small forest rising up in the boundary savanna in which indigenes perform their cult. The position of extant literatures is that though, the sacred groves in Nigeria are biological heritage and a system that has helped to preserve the representative genetic resources existing in the adjoining regions for generations; they are declining in number and size rapidly, due to modernization and urbanization.

2.2 Theoretical Framework

2.2.1 A Theoretical Process of Integrating the Indigenous Knowledge System

According to Tanyanyiwa *et.al.*(2011) adaptive characteristics of the indigenous knowledge system can be capitalized to facilitate its integration with the modern knowledge system for conservation of biodiversity. Of recent, several theoretical models and processes have been proposed as a result of the failure of the scientific knowledge system. For example, Ossai *et al.* (2010) proposed six steps for the integration of indigenous knowledge system into Information Communication Technology (ICT) that include recognition and identification of indigenous knowledge system, validation and recording and documentation. Others include storage in retrievable repositories, transfer and dissemination. Contrary to Ossai's six steps on integrating indigenous knowledge system, Cobb, (2011) proposed four steps for the integration of the indigenous knowledge system for climate change adaptation and mitigation of its effects that include documentation, valuing, stewardship and comanagement and discourse.

Of the two theoretical processes of integration of the indigenous knowledge system, the Cobbs' four -stage process is suggested for adoption in this present study, based on the following reasons. Firstly, validation of the indigenous knowledge system using scientific approaches is highly criticized, as these knowledge systems are originating from different worldviews, having different principles and each being a complete knowledge on its own. Therefore, validating one by using the other knowledge methods and approaches is unacceptable. Similarly, Maila *et al.* (2003) persuasively put it that illiterate people are only illiterate based on the scientific standards of evaluating their knowing. Based on indigenous standards, indigenous people are also intellectuals in their own worldview of knowing and doing, and that is why several intellectuals

and academics do consult traditional healers who are assumed to be illiterate according to scientific standards (Ntuli, 1999 cited by Maila *et al.*, 2003).

According to Ossai *et al.* (2010) a validation process involves an assessment of indigenous system knowledge's significance and relevance, functionality, effectiveness and transferability of such a knowledge system. However, based on the wholeness of the indigenous knowledge system, which includes but not limited to indigenous legal systems, norms, values, beliefs, sacredness, rituals, just to name a few (Robert, 1996 cited by Macgregor, 2008), a meaningful validation of the indigenous knowledge system in its wholeness is almost impossible.

Secondly, while Ossai *et al.* (2010) consider transferability of a knowledge system beyond its area of origin being one of the prerequisites for its meaningful integration with other knowledge systems, the indigenous knowledge system is location-specific. Thus, it cannot effectively and meaningfully be applied into a quite different context, as the knowledge is a product and part of humans' interaction in a particular supporting ecosystem. In the light of this contention, Thrup, 1989 cited by Tanyanyiwa *et al.* (2011) very clearly pointed out that the indigenous knowledge system that was adopted in a particular environment becomes inappropriate in a drastically changed environment, implying that indigenous knowledge system can only be meaningfully transferred in the same or similar context to which that knowledge system has evolved. Moreover, much of modern knowledge systems that have been introduced based on "one fit all" ideologies have been less successful, once introduced in a quite different ecosystem.

Similarly, Ossai *et al.* (2010) argue that indigenous knowledge system is rooted in particular cultural traditions, and transferring it to other places could result in dislocation of the same knowledge system. However, successful biodiversity conservation requires an

understanding of species. It is therefore, from the above arguments and similar views from other researchers and scholars on the indigenous knowledge system, that the Cobb's four steps of the integrating indigenous knowledge system is adopted by our study to guide the discussion around the theoretical integration process.

2.3 Empirical Studies

2.3.1 Indigenous and Modern Knowledge Systems as Concepts of Natural Resource

Management

The concept of indigenous knowledge has received increased attention by the academia and the development institutions but has not yet led to acceptable assessment of the concept. However, none of the definitions is essentially contradictory; they overlap in many aspects. Warren (1991) and Flavier (1995) present typical definitions by suggesting that:

Indigenous knowledge (IK) is the local knowledge -knowledge that is unique to a given culture or society. IK contrasts with the international knowledge system generated by universities, research institutions and private firms. It is the basis for local-level decision making in agriculture, healthcare, food preparation, education, natural-resource management, and a host of other activities in rural communities (Warren, 1999). Indigenous Knowledge is (...) the information base for a society, which facilitates communication and decision-making. Indigenous information systems are dynamic, and are continually influenced by internal creativity and experimentation as well as by contact with external systems (Flavier et al., 1995).

The indigenous knowledge system, in its broadest sense, encompasses cultural knowledge; social, political, economic and spiritual; kinship, local politics and other factors which are tied together and influence one another (Tanyanyiwa et al., 2011), whereas its spiritual nature influences how resources are managed and used by the people of that society (Berkes,

2008; Tanyanyiwa, *et al.*, 2011; Cobb, 2011). In this study, the indigenous knowledge system refers to a body of knowledge that has been generated, tested, improved overtime through the indigenous people's interaction with their supporting ecosystem, and that has been enhanced and safeguarded by norms, values, taboos, rituals and sacredness; that is interwoven within the context of local politics, spiritual and demographic characteristics of the people concerned.

The modern knowledge system refers to all methods and activities that are driven by theoretical models and, governed by testing of hypotheses and not necessarily utilitarian, often generalizable and not always location-specific, contrary to the indigenous knowledge system that is mainly based on one's experience (Ellis, 2005). The modern knowledge system tends to consider humans as manager and superior to other living and non-living organisms (Berkes, 2008; Cobb, 2011). The indigenous knowledge system considers humans as part and parcel of the supporting ecosystems and each of the components of ecosystem, including humans are interconnected and affect one another, and therefore deserve equal valuation.

It is from the above conceptualization, that this study refers to the modern knowledge system as all scientific principles, strategies, approaches and institutions such as conventions, government policies, strategies, rules and regulations that altogether govern humans' interaction with their livelihood supporting ecosystems. Indigenous knowledge systems include the knowledge of cultural beliefs, taboos, totems, indigenous agricultural practices and these were used to conserve and manage natural resources. Cultural taboos put restrictions on the use of plants, animals or areas and this helps to curb the depletion of natural resources considered important for the continuation of large communities.

Indigenous knowledge is passed on from generation to generation, usually by word of mouth and cultural rituals, and has been the basis for agriculture, food preparation, health care,

education, conservation and a wide range of other activities that sustain societies in many parts of the world. It also refers to knowledge and skills that have been developed outside the formal educational system. This kind of knowledge is embedded in the community and is unique to a given culture, location or society. It is the local knowledge that forms the basis for local-level decision-making in agriculture, human and animal health, food security, education, natural resource management, and a host of other activities in rural communities (Atte, 1992; Atte, 2004; Boven and Morohashi, 2002).

Berkes (2000) on the other hand reports that traditional knowledge is similar to western science in the sense that it is based on an accumulation of observations and should therefore be regarded as a complement to scientific knowledge. The following are the key features of indigenous knowledge which have relevance to conservation and sustainable development according to Dewalt, 1994; UNESCO, 2010; Tanyanyiwa and Chikwanha (2011):

- I Locally appropriate: indigenous knowledge represents a way of life that has evolved with local environment. So it is specifically adapted to the requirements of local conditions.
- II. Restraint in resource exploitation: production is for subsistence needs only; only what is needed for immediate survival is taken from the environment.
- III. Diversified production systems: there is no overexploitation of a single resource; risk is often spread out by utilizing a number of subsistence strategies.
- IV. Respect for nature: a 'conservation ethic' often exist. The land is considered sacred, humans are dependent on nature for survival, and all species are interconnected.
- V. Flexible: indigenous knowledge is able to adapt to new conditions and incorporate outside knowledge.

VI. Social responsibility: there are strong family and community ties, and with them are feelings of obligation and responsibility to preserve the land for future generations

Modern or formal conservation tool is achieved through the establishment of protected areas especially through national parks which are considered as the cornerstones for biodiversity conservation in Africa. According to Tijani (2007) conservation of biodiversity in National Parks is done through two main approaches: one approach is the preservation approach, which aims at setting aside National parks to exclude human activities except tourism. Through this approach, direct use of natural resources in the park for commercial or subsistence purposes is prohibited (Garven, 2006). Although many studies have been conducted on threats that protected areas face, there is a scarcity of literature that assesses why those threats have persisted.

Table 2.1: Differences between Science and Indigenous Knowledge

S/No	Factor	Science	Indigenous Knowledge
I.	How approached	Compartmental	Holistic
II.	How communicated	Written	Oral
III.	How taught	Lectures, theories	Observations, experience
IV.	How explained	Theory, “value free”	Spiritual, social values

Source: Modified after Brascoupé and Mann (2001)

Differences between Indigenous Knowledge and Modern systems are presented in table 2.1 and Table 2.2. In spite of these differences, Ajibade (2003) reports extensively on the need to incorporate indigenous knowledge into formal or modern knowledge system. He affirms that academic concern with indigenous knowledge dates as far back as the first intensive fieldwork by anthropologists, but it is only in recent years that the possibility of using such knowledge as a basis for natural resource management has been entertained.

Table 2.2: Comparisons between Traditional and Scientific Knowledge in Use

Indigenous scientific knowledge	Western scientific knowledge
Holistic approach	Compartmentalized approach
Lengthy acquisition	Rapid acquisition
Long-term wisdom	Short-term prediction
Prediction in local areas	Predictability in natural principles
Weak in predictive principles in distant areas	Weak in integrated, local areas of knowledge
Models based on cycles, accepting variability	Linear modeling as first approximation

Source: Modified from Alaska Native Science Commission (2011).

2.3.2 Indigenous Knowledge System and Conservation of Biodiversity

To date, several academics and professional are still not appreciating the significance of the indigenous knowledge system among others on sustainable development. That is why most of the initiatives have been relying on formal scientific knowledge (Bisong *et al.*, 2010). Biodiversity conservation initiative is one of such. In the light of this, despite several vivid examples on the significance of indigenous knowledge system on conservation of biodiversity (Berkes *et al.*, 2009; Berkes, 2008; Brokensha *et al.*, 2010), and notable geographical overlap between the world's biodiversity and cultural diversity hot spots (UNESCO, 2010; Bisong *et al.*, 2010), the significance of the indigenous knowledge system for conservation of biodiversity is increasingly being debated.

Opponents of the significance of the indigenous knowledge system argue that, for any practice to be considered as being conservation, such practice has to be intended for such conservation activities (Smith, 2012). So being conservational is both, a practice and an ideology (2006). For example, (Feit *et al.*, 2013; Larsen *et al.*, 2008; WFF, 2006) maintain that, although

sacred groves and forests and taboos contribute to conservation of biodiversity, they cannot be considered as conservational as they were not intended for such conservation.

Contrary to the opponents of the indigenous knowledge system, Berke *et al.* (2013) argued that conservation of biodiversity should not necessarily be the objective of the practice but the consequences of it. Moreover, several vivid examples show that the indigenous knowledge system has been intentionally and significantly contributing to conservation of biodiversity. For example, restriction on over fishing, freeing of surplus fish during spawning season and expulsion of offenders of traditional rules and taboos (Mwale and Malekano, 2000 cited by Kalanda-Sabola *et al.*, 2007), have been significantly contributing to sustainable management and use of biodiversity.

Kideghesho, (2008) in his study also found that indigenous conservation regulations such as hunting of adult and male animals and restriction of hunting wild animals during breeding seasons have been contributing to conservation of biodiversity. This implies that restrictions of fishing during spawning season, hunting of adult male animals and hunting during breeding season had a conservation ideology; otherwise those restrictions could have not been on a specific period of the year and specific sex of an animal.

Summing up the discussion on whether the indigenous knowledge system was conservational or not, Kideghesho, (2008) argued that whether traditional and mythical values are conservation-oriented or not, their influence on conservation of biodiversity should not be ignored, as what matters is the success of whatever system is used. Moreover, at this era of biodiversity decline, to keep arguing whether the indigenous people and their knowledge system is conservational or not, rather than fostering them, is valueless (Holt, 2005). It is from this

background this paper argues that the indigenous knowledge system on its holistic nature of the knowledge and on its own ways of knowing and doing is conservational (Kideghesho, 2008).

2.3.3. Synergy between the Indigenous and the Modern Knowledge Systems in *in-situ*

Forest Biodiversity Conservation

A synergetic relationship between the indigenous and the modern knowledge systems is widely accepted and relatively well documented. For example, a study carried out in Xishuangbanna, Southwest China from 1993 to 1999 revealed that reduction of taboo practices resulted in decline in revered plant species, despite the legislations for their conservation (Hongmao *et al*; 2003 cited by Nganje, 2009). Similar findings were reported by Nganje, (2009) in his study carried out around the Ankassa, Bia and Kakum forest conservation areas in Ghana. The study revealed that neither the scientific knowledge system nor taboos alone conserved biodiversity; rather, their combination achieved what neither could alone.

Similarly, Stevenson, (2005); Fitzgerald *et al.*(2009); Cobb, (2011) and Kajembe *et al.*(2010) insisted that the indigenous and the modern or scientific knowledge systems do complement each other on their strengths and weaknesses and their integration would achieve more than neither in their separation. In conclusion, without doubt, many scholars suggest that the indigenous and the modern knowledge systems are synergetic and do complement each other on their strengths and weaknesses, and their integration might achieve what cannot be achieved by either in their separations.

According to Morgan (2003), the indigenous knowledge system makes no distinction between the physical and spiritual fields of understanding, and despite its dynamic and diverse nature, the indigenous knowledge thinking is mostly holistic and contextual. The scientific

worldview or modern system differs with the indigenous worldview, among others, by its classifying species diversity as being hierarchical and into different families and level of sophistication, with human perceived as distinct from and superior to the modern system (Mokuku *et al.*, 2004, Osunade, 1994; Ajibade, 2001).

This implies that while the indigenous worldview gives full respect to all living and non-living things, and believes that their conservation is a duty of all the organisms from tiny to large animals, the scientific worldview considers other species as being inferior, and that they have no spiritual value and are for human utilization and management, For instance, increasing rate of firewood collection and killing of wild animals, and the use of land for farming and building constitute great threat to existence of the sacred forests. Adoption of Christianity and Islam by the people is also contributing to the neglect of cultural beliefs that are in support of the sacred forests.

To prevent further encroachment into the sacred forests, there is need for proper demarcation of the boundary for protection against pressing land uses and over exploitation. Also, the current traditional knowledge and beliefs in support of sacred forest should be properly strengthened to control unsustainable exploitation in the forests (Babalola *et al.* 2012).

Results of a comparison between sacred groves and formal reserves have shown that sacred groves shelter a high diversity of medicinal plants and have more vigorous regeneration of trees than do formal reserves (Borairah *et al.*, 2003). Some studies that were carried out in India concurred that sacred groves have higher tree species diversity than do formal reserves (Bhandary and Chandrashekkar 2003; Jamir and Andey 2003; Ramanujam and Cyril, 2003).

Arguing on the perceptions of the indigenous people on other species biodiversitiesT'seleie, 1997 cited McGregor, (2008) elucidates that to be a human is to be able to

understand the world and to live in it, to be part of it, to learn to understand the animals, for they are our brothers and they have much to teach us, as we are part of this world. This implies that while the scientific worldview considers human beings as superior to other creations, and as managers of other creatures, the indigenous worldview considers all creations being God's creations: all deserve equal respect, no specie is subordinated to another. Such difference in the worldviews attributed to the endless conflicts between the indigenous people and scientists as a result of different approaches in achieving the same vision of attaining sustainable management and use of biodiversity (Holt, 2005).

Arguably, a win or lose relationship between the indigenous and the modern knowledge systems that has been mainly dominated by the scientific approaches, strategies and methods and practices for the conservation of biodiversity, has resulted in the harmonization of the teaching and learning processes based on the scientific knowledge system, therefore, underpinning the integration of these knowledge systems. The importance of this traditional knowledge for the protection of biodiversity and the achievement of sustainable development is slowly being recognized internationally (Gadgil *et al.*, 1993).

For example, Article 8 of the Convention on Biological Diversity urges us to "...respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity...."(United Nations, 1992). In addition, traditional or indigenous knowledge has been rediscovered as a model for a healthy interaction with, and use of the environment, and as a rich source to be tapped in order to gain new perspectives about the relationship between humans and nature. Some of the empirical results and the knowledge gaps are presented in Table 2.3.

Table 2.3: Overview of some of the Empirical Studies

Author(s) and years of study	Area of Studies	Results	Gaps
Tsepo Mokuku and Chaba Mokuku (2004)	The Role of Indigenous Knowledge and Biodiversity Conservation in the Lesotho Highlands: Exploring indigenous epistemology	The results indicate that there are practices and beliefs about certain species that contribute towards their conservation. Through these beliefs, species are perceived to have powers to cause certain awesome consequences for humans.	The indigenous approaches is incidental in biodiversity conservation and the modern indigenous system which is referred to as the planned or conventional approaches are commonly used to sustain biodiversity. Past and current studies show that both approaches are generally ineffective in conserving biodiversity in Africa. However, there are a handful of cases where these approaches have been successful at conserving biodiversity. The current study is of the opinion that the conservation of forest resources and biodiversity through modern approaches is observed to have significantly ignored the focus of this study especially the sacred grove established on the indigenous knowledge of the people of Osogbo and the National Park established based on the modern and scientific knowledge to protect and preserve and conserve indigenous biodiversity. An attempt to fill such gaps was the main thrust of this research
Kideghesho, (2008)	Co-existence between the traditional societies and wildlife in Western Serengeti, Tanzania: Its relevancy in contemporary wildlife conservation efforts	The study concluded that whether traditional and mythical values are conservation-oriented or not, their influence on conservation of biodiversity should not be ignored, as what matters is the success of whatever system is used.	
Holt,(2005)	The catch-22 of conservation: Indigenous people, and cultural change	Holt in his findings, concluded that at this era of biodiversity decline, keeping arguing whether the indigenous people and their knowledge system is conservational or not, rather than fostering them, is valueless. It is from this background this paper argues that the indigenous knowledge system on its holistic nature of the knowledge and on its own ways of knowing and doing is conservation	
Jimoh et al. (2013)	The paper highlights traditional laws, values and taboos in wildlife Conservation in the Oban Hiill Sector of Cross River	Their study concluded that the existence of traditional laws and taboos is effective in achieving wildlife conservational objectives	

		in the area.	
Ajibade,L.T& Shokemi (2003)	The author states that these systems enable the farmers and other local people to make the most of irregular rainfall, and argues that these methods can sustain a delicate balance between cropping and their livelihood which is both environmentally and socially appropriate. Indigenous approaches to weather forecasting in Asa LGA, Kwara State, Nigeria.	Their study stressed the effectiveness of indigenous approaches to weather forecasting and called for their integration with the scientific approaches.	
Tanyanyiwa, I. V. & Chikwanha, M. (2011).	The role of indigenous knowledge systems in the management of forest resources in Mugabe area, Masvingo, Zimbabwe	The paper highlights the contribution of indigenous knowledge and the relevance of traditional practices in the management of forest resources in Masvingo areas of the Zimbabwe.	
Babalola,F.D, (2014)	Potential and Challenges of Indigenous Knowledge in Conservation of biodiversity in Osun Osogbo Sacred grove ,Nigeria	The paper highlights the potential and challenges facing the grove like pressure from population explosion and urbanisation process, poaching and deforestation.	

Source: Authors Survey (2016)

CHAPTER THREE

3.0 RESEARCH METHODS

3.1 Introduction

This section discusses the research methods employed in carrying out this study in order to accomplish the stated aim and objectives. Research, according to Adedayo (2003) and Jimoh (2005) is a way of gathering useful and dependable information; it is a series of systematic activities carried out to find answers to identified problems in a particular discipline. In geographical analysis, research methodology contains a complex network of procedures ranging from conceptual model of classification to language of the research to manipulate data. This section attempts to identify the choice of data collection, types of data required, sources of data sample and sample techniques and analytical framework for the research. Due to the nature of the work, the study was carried out using a Mixed Methods perspective in mixing and matching components of the basic Quantitative and Qualitative methods to improve the understanding of the subject at hand (Creswell 2003; Tashakkori and Teddlie, 1998). The aim is to analyze the indigenous and modern knowledge systems for *in-situ* forest biodiversity conservation using sacred grove and a national park as tools. The sacred grove was selected for this study due to its cultural significance and contribution to biodiversity conservation at the local, national and international levels. Due to the significance and recognition given to the grove, it is culturally and legally protected by the Federal Military Government of Nigeria Decree 77 of 1979. The Old Oyo National Park was equally selected due its ecological and biodiversity significance and has been the only well -established protected area in the southwest region of Nigeria.

3.2 Data Required for the Study

Data required include data on:

- i. population distribution of the selected communities in the buffer zone of the sacred grove in Osun and the national park in Oyo;
- ii. map of the study area in relation to the location of the states in relation to vegetation, soil and land use maps;
- iii. roles of sacred grove and national park in biodiversity conservation;
- iv. species relative indices, and species relative dominance (diversity indices), species abundance;
- v. major factors affecting forest biodiversity conservation;
- vi. the relationship between the techniques of indigenous knowledge systems and the modern knowledge and the communities' preferences for biodiversity conservation; and
- vii. perceived level of relative effectiveness of indigenous and modern methods of conservation of biodiversity..

3.3 Sources of Required Data

3.3.1 Primary Data Sources

I. Reconnaissance Survey

This is the first stage of the field research and the purpose of the survey is for the researcher to get familiar with the terrain of the study area, identify the sample population and take cognizance of their socio-economic characteristics. The stage is significant because it exposes the researcher to identify more variables to be included in the questionnaire.

II. Questionnaire Administration

At this stage, a well -structured questionnaire comprising both open ended and closed ended questions was designed. Open ended questions enable respondents to satisfactorily express themselves while the close ended questions provide a limited number of options as answers.

However, close ended questionnaires were administered for the purpose of the respondents subject to the responses from chief priests, head of households, forest and park officers and other members of the communities who have served as key informants in the area under study (Appendix A).

III. Participatory Rural Appraisal (PRA)

Participatory Rural Appraisal refers to a group of methods, which include participant observation, focus groups discussion and participative mapping. The primary focus of PRA therefore, is using problem owners as partners in the research process; they have relevant knowledge and learn and apply solutions better when they are part of the research. This study was partly conducted using this qualitative technique with the support of some indigenes who served as research assistant. Key individual informants were identified and interviewed in each of the communities around the grove and the national park. Additional useful information was also garnered through focused group discussions which involved both youths and elderly folk. Considering the immense benefit of PRA, the method was employed to generate first-hand information on:

- i. Understanding the indigenous knowledge regarding local resources- flora, fauna, livelihood options, perceptions and motivation of different biodiversity user groups through Focus Group Discussion (FGP) The purpose of the FGD is to obtain information about a people's beliefs, values, attitudes and norms on a particular issue. Focus group discussion is quite different from individual interviews or surveys because the discussion allows for interaction among all the community, members. The FGD covers selected senior members such as the chief priests, elders and head of households (Key informants from the communities). This allowed for a wider coverage of investigation and a better understanding of the variables. (See Appendix A)

ii The extent to which local community benefits and whether these benefits impact on local behaviour in a manner consistent with biodiversity conservation and sustainable objectives particularly in reducing poaching in to the sacred grove and the national park.

III. Interview Method

Interview is a survey method of research involving a person seeking the information called the interviewer and another giving the information, called the respondents (Asika, 2006). The interviewer armed with an interview schedule, meets the respondents and completes the interview schedule himself. In effect, personal interview uses an interview schedule, which is completed by the interviewer himself. Unlike the questionnaire, the interviewer often goes beyond what is contained in the interview schedule to ask questions for clarifications in order to enrich the responses. The greatest advantage of this form of survey research according to Ogundipe, Lucas and Sani (2005) is that it eliminates some of the problems encountered in questionnaire-based research, such as ambiguous wordings, ill-defined categories and inadequate measuring instruments.

In line with the above, an interview schedule tagged in depth interview check list was designed for the study. The interview schedule was divided into two parts. Part I consists of the knowledge of the study areas, Part II seeks to find out how the subjects perceive forest biodiversity conservation and management in Osun grove and the National Park.

IV. Observations

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 (2006) 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. The participant guided field observation method was carried out to complement the findings in the FGD and the questionnaire on the current use of forest resources in the areas. Though the research team was not allowed to take photographs of shrines, photographs of other places were taken.

V. Fieldwork

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 line transects of 100m long and at a distance of 50m apart were laid within the sacred grove and the national park. Tree species within 20m on either sides of the line transect were identified and recorded accordingly. Four plots of size 50 × 50m were each laid on two transect lines of length 300m. 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 × 50m were laid on two transect lines of length 300m each and separated from each other by 300m every 75m 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.

3.3.2 Secondary Data Sources

- i. General information on the characteristic features of the study area was sourced from relevant texts, seminar papers, published and unpublished materials, the internet, and newsletters.
- ii Information on the location and spatial features of the study area was obtained from maps collected from the Federal Survey Office and the Surveyor-General of the Federation office.

iii. Information on demography and population disaggregated data for the study were obtained from National Population Commission Office and the State Ministry of Planning and Economic Development.

iv. Information on vegetation, soil, climate, geology and relief of the study area was sourced from the Grove Management, National Park Management and the State Ministry of Environment and Forest Resources.

3.4 Sampling Techniques

A multistage sampling procedure was employed in this study. First, all settlements that fall within 0-10km of the boundary of Old Oyo National Park (OONP) were selected to form sampling frame (Tijani,2007; Alarape,2003). Similarly, all the communities in the buffer zone of the Osun Osogbo grove totaling about 47 ha with an average population of 108,092 (Osun state gazette, 2012) comprising a total of nine communities were also selected to form sampling frame (See Figure 3.1).

There are 10 communities covering approximately 20,000 hectares and 19,000 households in the buffer zone of Old Oyo National Park. To accomplish this, three main criteria were used namely: proximity to OONP boundary; geographical distribution; and perceived impact of each community on the Park (See Fig.3) showing the buffer zones of OONP).

The adoption of the criteria during the reconnaissance survey yielded a sample that included Tede, Sepeteri, Igbo-Ologun, Abaja, Dogari Iju, Ajebandele, Abaja, and Soro. The Total population was obtained from the National Population Commission (1991) and was based on the 1991 population census. This is the last census available at disaggregated community level. The geographical distribution; and perceived impact of each community on the Park (See Figure 3.1). This was further projected to 2015 using 3.2% percent annual growth rate of rural areas in Nigeria (World Bank, 2014).

The result of the projection is as shown in (Table 3.1). With respect to the sample size, the study applied the Raosoft Online Sample Size Calculator (2004) to obtain a required sample size for this study. The online sample size calculator is a simplified way of obtaining sample sizes for research purposes. Systematic random sampling technique was adopted based on the total number of households divided by the sample size (See Table 3.1). The interval vary from one settlement to another, that is an interval between 1-3 household in this study.

Letters were sent to all support zone communities and settlements in advance intimating them of the days and dates of visits (See Table 3.1). A total of 378 copies of questionnaire were randomly distributed to the respondents in 9 settlements within ten kilometres (10km) radius to the Park boundary in the five Ranges namely; Marguba Range, Tede, Yemeso, Sepeteri, and Oyo- Ile. The proportional allocation of the questionnaire was done based on the result of Raosoft Online Sample size in Table 3.1. Interpreters in Yoruba language were employed for some respondents especially the Non-Nigerians. Also, focus group was convened in each village sampled at open ground to discuss on the issues that are important for management decisions. However, there was repeated visit to the study area in order to make an on spot assessment of the true situation in terms of biodiversity conservation, rural support needs and park oriented project in those settlements (Fig.3.1 showing the buffer zones of OONP).

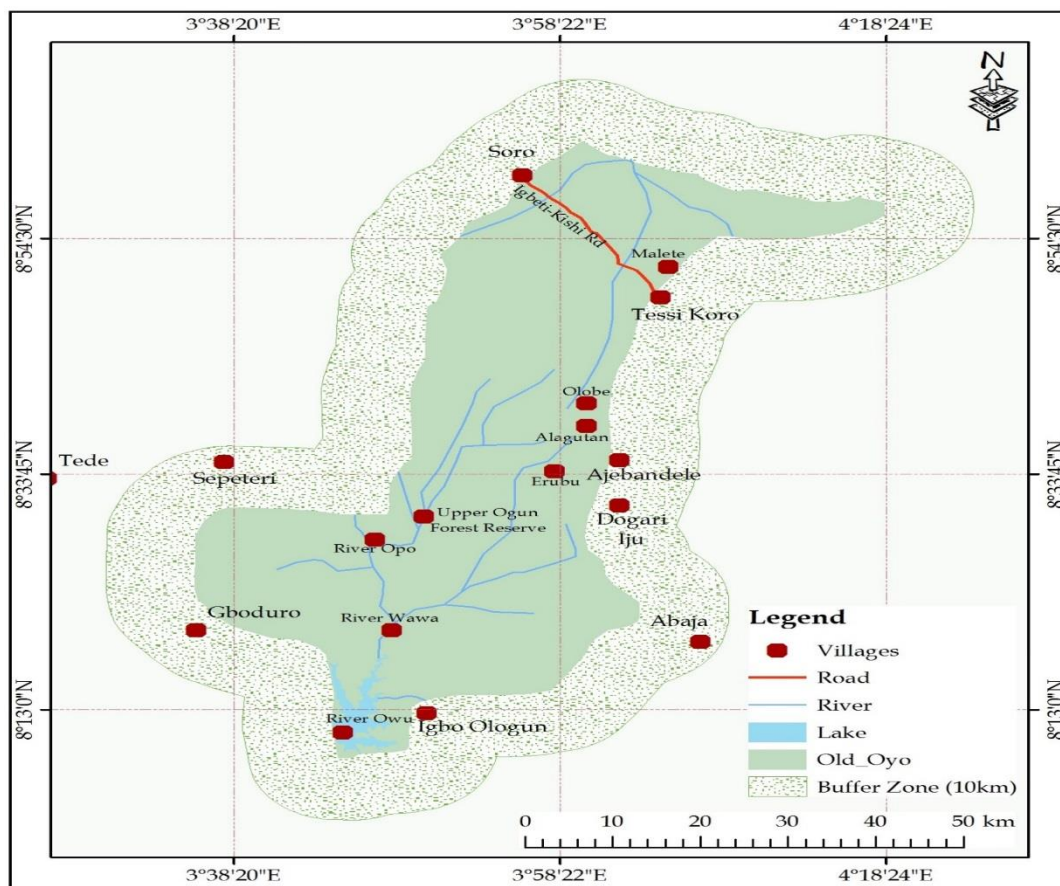


Figure 3.1. Buffer Zone and sampled areas of OONP.

Given margin of Error (confidence interval) = 5% (usually a common choice)

Confidence level = 95% (other typical choices are 90% or 99%)

Population size =113,104 (total projected population to 2015)

Sample size = 378

Furthermore, the samples for each settlement were calculated as a proportion of the sample size in relation to the population of each settlement as shown in (Table 3.1).

Table 3.1:The Population Structure of Sample Settlements

S/ N	Name of Settlements	Population Structure		Total 1991	Total 2015	Respondents per settlement
		Male	Female			
1.	Tede	24,541	27,229	29,282	51,770	173
2.	Sepeteri	15,567	18458	19245	34,025	113
3.	Igbo-Ologun	8571	8248	9,600	16,819	56
4.	Gboduro	1197	1333	1,412	2530	9
5.	Abaja	1417	1368	1,577	2787	10
6.	Dogari Iju	180	205	2,181	385	1
7.	Ajebandele	1412	1324	1,546	2736	9
8.	Tessi Koro	430	490	503	920	3
9.	Soro	582	550	640	1132	4
Total		13,515	16,315	64,025	113,104	378

Source: (A) NPC, 1991 (B) Researcher's Computation 2016

Moreover, the disaggregated NPC 1991 and 2006 population census was not available for settlements within the buffer area of the Osun grove (See Fig.3.2). However, the state government's gazetted population for all the communities was used for the projection from 108,092 in 1991 to 191,107 in 2015. Hence, a total of 161 questionnaires was administered among the communities in the buffer zone in Osun Osogbo grove, this figure was arrived at using the Raosoft.Calculator Method (.Raosoft Online.com 2004). The online sample size calculator is a simplified way of obtaining sample sizes for research purposes. Systematic random sampling technique was adopted based on the total number of households divided by the sample size (See Table 3.1).The interval vary from one settlement to another, that is an interval between 1-3 household in this study.



Plate 3. 2.:Focus group discussion session in Marguban Range (OONP)Settlement



Plate; 3.2: Entrance to the Sacred Grove Igbo Oro.

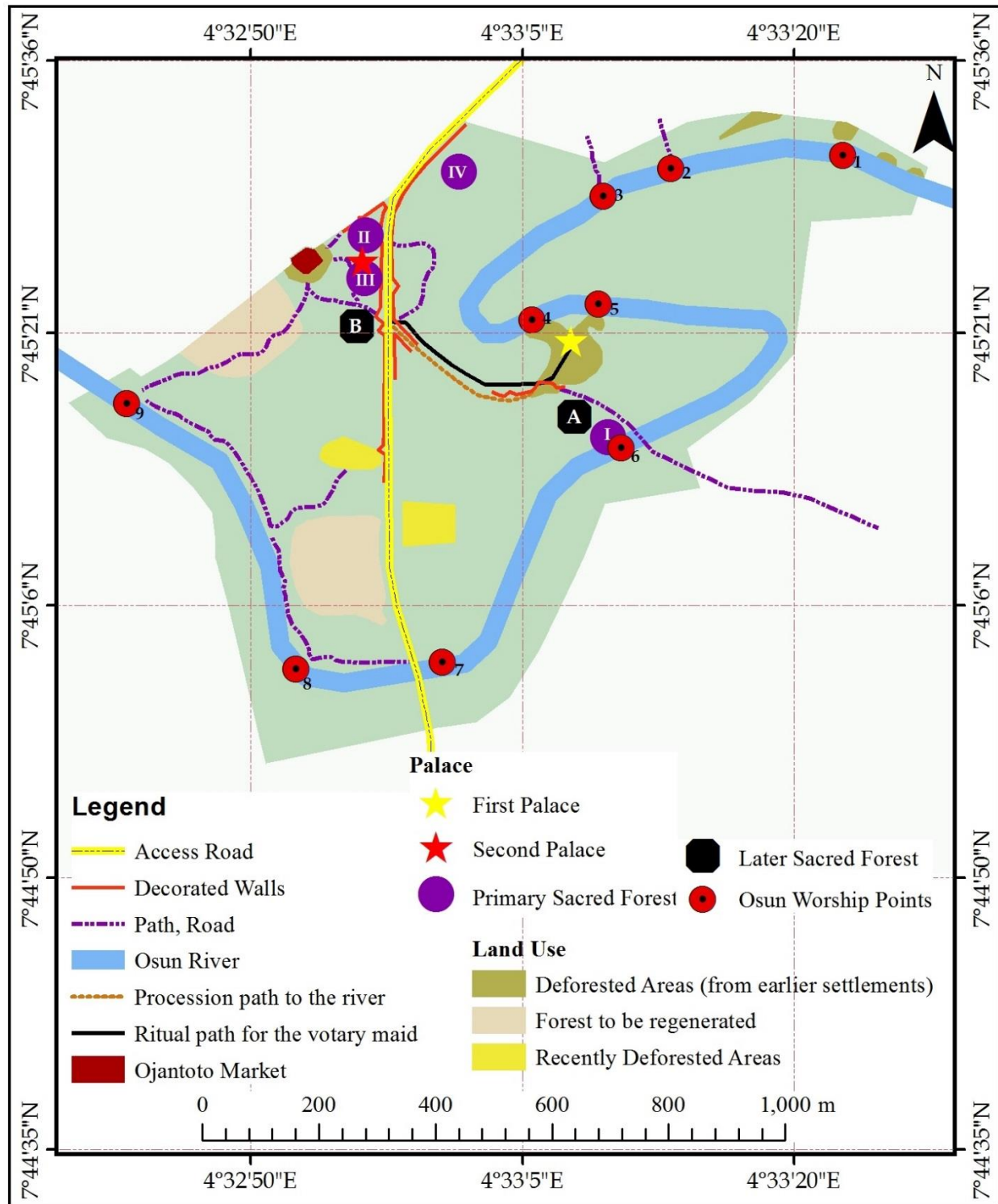


Figure 3.2. Buffer Zone and sampled areas of Osun Grove.

3.5 Sources of Required Data

The data needed for this research work were obtained from the above itemized sources which are both primary and secondary data. The primary research data was obtained from the data set iii, iv, v, vi, vii, viii and ix above are the primary data while data set i, and ii were the secondary.

3.6 Sampling Frame

A multistage sampling was employed in this study. First, all settlements that fall within 0-10km from the boundary of Old Oyo National Park (OONP) were selected to form sampling frame. Similarly, all the communities in the buffer zone of the Osun Osogbo grove adding up to 47 hectares with a population of 108,092 (Osun State Gazette) comprising nine communities were also selected to form sampling frame.

3.7 Methods of Data Analysis

Both descriptive and inferential statistical techniques were adopted to analyze the data collected for the study. The qualitative part employed descriptive model in qualitative content analysis to bring together important components of respondents' views and information, which emerged repeatedly or were seen as significant across interviews. The quantitative part involved the use of statistical analysis to test the validity of findings. Simple descriptive statistics of tables, charts and simple percentage were utilized to summarize and organize data gathered from questionnaire administration. One-way Analysis of Variance (ANOVA) was used to test for significant differences between diversity indices and other parameters of the two sites using SPSS 22.0. Other specific techniques used include:

- i. Discriminant and classification analysis which are multivariate technique concerned with separating distinct sets of objects (or observations) and allocating new observations (objects) to previously defined groups (population). This technique was employed in the classification of the study areas, based on individual belief systems, into either indigenous or modern conservation tools.

- ii. Species relative density (RD) and species relative dominance (RD₀) 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.

$$RD = n / N * 100 \dots\dots\dots \text{Equation 1}$$

Where:

RD-relative density,

n=number of individuals per species and

N= total number of individuals in the entire population.

$$RD_0 = \frac{\sum Ba_i^2}{\sum Ba_n} * 100 \dots\dots\dots \text{Equation.2}$$

Where:

RD₀ = relative dominance

Ba_i = basal area of individual tree belonging to the ith species and

Ba_n = stand basal area.

Species diversity index was calculated using Shannon–Wiener diversity index [equation 3] (Onyekwelu and Olusola, 2014).

A common methodology has been set up for the research work at the study sites, Osun grove and OONP. As a standard sampling procedure for woody species, eight plots of size 50 × 50m were each laid along two 300m 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 × 50m were laid on two transect lines of length 300m each and separated from each other by 300m, every 75m 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 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 (Curtis and McIntosh, 1950; MacArthur and MacArthur, 1961; Onyekwelu and Olusola, (2014). 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) (Savadogo *et al.*, 2007). 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 (Mueller Lombors and Ellenberg 1974; and Babalola (2014).

The IVI was given as:

$$RF (a/b * 100) + RD (c/d * 100) + RA (a/q * 100) \text{ ----- Equation3}$$

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

$$\text{Species Richness } D = \frac{S}{\sqrt{n}} \text{Equation 4}$$

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 (E_n) equation was adopted from estimating species evenness and their exponentials ($\exp H'$) were computed based on Jost (2007) and Onyekwele and Olusola (2014).

$$H' = \sum_{i=1}^S P \ln (P_i) \dots\dots\dots \text{Equation 5}$$

Where:

H' = Shannon diversity index,

S = total number of species in the habitat,

P_i = proportion of S which made up of the i th species and

$\ln$ = natural logarithm. (Onyekwelu and Olusola, (2014).

- iii. One-way ANOVA technique was employed to determine the relationship between the tree species parameters in Osun grove for biodiversity measurement..
- iv. Duncan's Multiple Range Tests was used to draw conclusions on various parameters studied in both Osun -Osogbo and Old Oyo National Park.
- v. Simple Percentage, frequency, table, chart and mean were used to analyze the perception on human activities and conservation of biodiversity.

CHAPTER FOUR

4.0 DATA ANALYSIS AND PRESENTATION OF RESULTS

4.1 The Level of Perception on Indigenous and Modern Knowledge System of Forest Conservation Methods in Southwestern Nigeria.

Individual belief system in Southwestern Nigeria is classified especially based on the biodiversity conservation approach adopted in the management of the forest biodiversity in Osun Osogbo Grove (OOG) and the Old Oyo National Park (OONP). The study reveals that 96.9 % of the respondents in Osogbo supported the classification of biodiversity conservation based on the use of indigenous ecological knowledge which have been in existence for centuries. This indigenous ecological knowledge is embedded in the complexity of local people's lives.

The study further revealed that a greater number of respondents comprising residents (98.1%), stakeholders (97.5 %) and staff (90.1 %) respectively attached their belief system in biodiversity to the use of sacred grove with strict codes of conduct; supporting taboos and prohibitions from extracting natural resources and other nature-based activities (See Table 4.1). The traditional forest biodiversity conservation approach also include a respect for Osun goddess, other sprits and deities in the sacred grove (90.1%) which has in place it taboos, rules, sanctions, rituals and ceremonies as well as make sacrifices ..In order to protect this belief system of the people of Osogbo and their culture from external influences, some taboos and prohibitions are additionally imposed, appropriate to the cultural context, which has significance to them. The sacred grove is protected by the indigenes due to its potentially valuable biodiversity nature over many centuries ago. This belief system shows that indigenous ecological knowledge is embedded in the complexity of Osogbo community's lives with rules, taboos, sanctions, rituals, and ceremonies which have significance underpinning indigenous practices and knowledge. .

A greater number of respondents in Old Oyo National Park communities, on the other hand, based on their understanding of the scientific method of forest biodiversity conservation in their areas have classified protection of biodiversity established their belief on modern ecological knowledge system (See Table 4.1) as operated in their localities. This classification was attached to the establishment of national park (90.1%), protection of forest biodiversity from threats and encroachment (92.6%), development of new approaches and strategies for biodiversity management (87.8%) and categorization of forest areas as habitats for natural ecosystems, wildlife, and other natural resources. The Old Oyo National Park is a modern biodiversity managed large areas of forest resources and wildlife which plays a critical role in ecosystem services like the OOG both are found in Southwestern Nigeria.

Supporting the descriptive statistics on individual classification system established, and in determining of adoption of indigenous and modern knowledge system, two different models were derived for the two *in-situ* biodiversity conservation areas in Southwestern Nigeria. In order to properly classify the individual belief systems, first in Osun Osogbo and second, in Old Oyo National Park, both in the Southwestern Nigeria, discriminant and classification analytical technique was used to determine this.

Two different models were derived for the two *in-situ* biodiversity forest conservation areas in this study, this is in line with the reports of Hens (2006), Tamuno, (2014); and Jimoh et al, (2012). One indigenous in nature, 'Igbo Oroo based on myths and involves the traditional forest management system with sustained forest yields over several centuries ago, while modern protected area, that is, Old Oyo National Park (OONP) is formal in nature and scientific technique based. However, two different centroids were generated for this model. For instance,

Osun Osogbo sacred grove (Igbo Oro) has the classification mode stated as follows with a total respondents of n = 161 generated across the communities surrounding the sacred grove.

Table 4.1: Belief System of Respondents in Biodiversity Conservation Approach in the Study Area

Belief System in Biodiversity Conservation	Frequency – Osun Grove n=161	Percent (%)	Frequency – OONP (n=352)	Percent (%)	Cumulative (%)
Indigenous/Traditional Ecological Approach					
-Use of Sacred forest	156	96.9	5	3.1	100
-Local Institution have rules	158	98.1	3	1.9	100
-Use of taboos/Prohibition	157	97.5	4	2.5	100
-Respect traditional sprints/deities	145	90.1	16	9.9	100
Modern and Scientific Management Approach					
-Developing national park	35	9.9	317	90.1	100
- Protecting forest from threats	26	7.4	326	92.6	100
-Development of new techniques for biodiversity management	32	12.2	309	87.8	100
- Categorisation of forest areas	14	4.0	338	96.0	100
	161		352		

Source: Author's Fieldwork (2017)

The models generated using respondents socio-economic variables are:

$$Y_0 = 0 + G + F + M + R + L + I + LE + S + A \quad \text{-----Equation1 [Indigenous Variables]}$$

$$Y_1 = 0 + G + F + M + R + L + I + LE + S + A \quad \text{----- Equation 2 [Modern Variables]}$$

.While the centroid for this model is 0.005 significant level, the model with their corresponding coefficients and their coefficients are stated as follows:

$$Y_0 = 38.619 + 0.93G + 0.365F + 2.44M + 3.494R + 1.08L + 0.00077I + 0.952LE + 5.14S + 0.346A \quad \text{-----Equation 1 (Indigenous)}$$

$$Y_1 = 37.939 + 0.870G + 3.358F + 2.355M + 3.265R + 0.996L + 0.000778I + 0.943LE + 5.473S + 0.345A \quad \text{-----Equation 2 (Modern)}$$

G = Government effect (-0.41)

F = Farming activities (0.77)

M = Marital Status (0.249)

R = Religion Beliefs (0.493)

L = Occupation (0.634)

I = Income level (-0.148)

S = Sex of respondents (-0.533)

LE = Level of Education (-0.077)

A = Age of respondents (0.054) [Author's Statistical Results, 2018]

The discriminant values generated for this model are $Y_0 = 38.619 + 0.93 (-.41) + 0.365(0.77) + 2.44 (-.249) + 3.494 (.493) + 1.08(.634) + 0.00077(-.148) + 0.952(-.077) + 5.14(-.533) + 0.346(-.054)$ is 41.45 at significant level of 0.005 while $Y_1 = 37.939 + 0.870(-.41) + 3.358(0.77) + 2.355(-2.49) + 3.265 (.493) + 0.996(.634) + 0.000778(-.148) + 0.943(-.077) + 5.473(-.533) + 0.345(-.54)$ at 0.05 significant level is 36.04. It could therefore be inferred from the model that factors such as religious beliefs, occupation, marital status and the age of respondents significantly determined the position of respondents on classifying and understanding indigenous knowledge as playing key roles in *in-situ* forest biodiversity in Osun grove. Therefore, these are the factors that determine their opinion.

In the case of Old Oyo National Park, the model generated, based on the total number of respondents was $n = 352$. The first model generated was Y_0 representing the indigenous conservation technique -Osun Grove.

$Y_0 = 41.636 + 0.93(G) + 0.365(F) + 2.44(M) + 3.494(R) + 1.08(L) + 0.00077(I) + 0.952(LE) + 5.14(S) + 0.346(A)$ this amount to 41.42 while the second model covering the modern strategic approach in *in-situ* forest biodiversity conservation

$Y_1 = 37.939 + 0.870(G) + 3.358(F) + 2.355(M) + 3.265(R) + 0.996(L) + 0.000778(I) + 0.943(LE) + 5.473(S) + 0.345(A)$.

These models are now being classified by inserting the given values for the variables obtained in the field-centroid.

$Y_0 = 41.636 + 0.93(-0.41) + 0.365(0.77) + 2.44(0.249) + 3.494(0.493) + 1.08(0.634) + 0.00077(-0.148) + 0.952(-0.77) + 5.14(-0.533) + 0.346(.054)$ this amount to 41.42 while the second model.

$Y_1 = 37.939 + 0.870(-0.41) + 3.358(0.77) + 2.355(0.249) + 3.265(0.493) + 0.996(0.634) + 0.000778(-0.148) + 0.943(-0.077) + 5.473(-0.533) + 0.345(-0.054)$ equal to 58.04 at 0.02 significant level. This figure indicates that the coefficients above with government policies, the respondent income level, their education level, age and gender, significantly contributed in classifying the two knowledge systems in southwestern Nigeria. Indigenous knowledge systems significantly contribute to the biodiversity conservation in Osun Osogbo sacred grove. According to the respondents, traditional belief systems and practices using taboos, myths and superstitions prevented misuse of forest and animal resources in the grove. However, any violation of such local customs attracts serious sanctions including sacrifices from fellers, etc.

From the analysis above, the result of our model is significant, which implies that all the coefficients played significant roles in classifying the conservation areas based on their knowledge systems into indigenous and modern and each of these is key in its roles in preserving

forest biodiversity in Osun Osogbo sacred grove (Igbo Oroo) and OONP in the southwestern Nigeria.

In a similar vein, the identified variables played key roles and were used in the classification of the study areas in line with their belief systems, especially based on the conservation methods used in the management of OOG and OONP. Figure 4.1 and Figure 4.2 show the map classifying the two approaches and the forest species associated with each study site. The maps (Figures 4.1 and 4.2) also indicated the relative density of the species resulting from the management approaches adopted based on the contribution of each knowledge systems, indigenous and modern respectively and their trees diversity indicating their biodiversity status. The resulting models combination may be used as a linear classifier or, more commonly, for dimensionality reduction before later classification. Two approaches, indigenous knowledge system (see equation 1) and modern knowledge systems (equation 2), were investigated to discriminate the origin of these knowledge systems in terms of their contributions to *in-situ* forest biodiversity. The classification assigned a class to each biodiversity conservation practice from individual knowledge systems leading to the generation of two models (equation 1 and 2). With this approach, the differences in the conservation of biodiversity from two origins were reflected intuitively.

Species	Relative Density Index (Sacred Grove)
Agevaceae	0.000237
Anacardiaceae	0.000947
Annonaceae	0
Apocynaceae	0.005917
Araliaceae	0
Arecaceae	0
Bignoniaceae	0.000237
Bombacaceae	0.000947
Borognaceae	0.000237
Burseraceae	0
Caesalpinioldeae	0.003787
Celastraceae	0
Chrysobalanaceae	0
Combretaceae	0
Dilleniaceae	0
Dipierocarpaceae	0
Ebenaceae	0
Erythroxylaceae	0
Euphobiaceae	0.008521
Fabaceae	0
Hymenocardiaceae	0
Invingiaceae	0
Locythidaceae	0
Loganraceae	0
Meliaceae	0.00213
Mimosoidaeae	0.015148
Moraceae	0.015148
Myristicaceae	0
Ochnaceae	0
Olacaceae	0.000237
Papilioniodeae	0.003787
Rhizophoraceae	0.000237
Rabiceae	0.000237
Rutaceae	0.000947
Sapindaceae	0.00213
Sapotaceae	0.00213
Simaroubaceae	0
Sterculiaceae	0.008521
Tiliceae	0
Ulmaceae	0.000947
Unknown	0.000237
Unknown	0
Violaceae	0

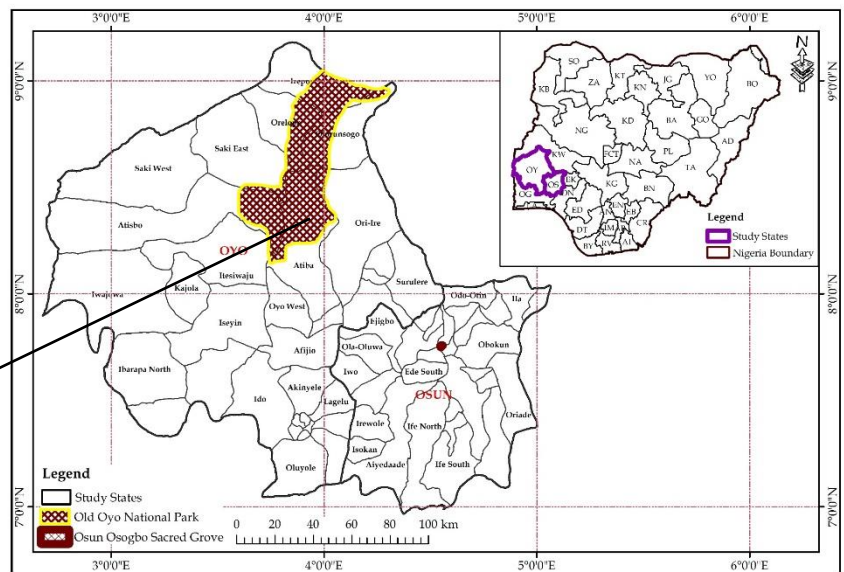


Figure 4.1: Map of the Grove and the tree diversity

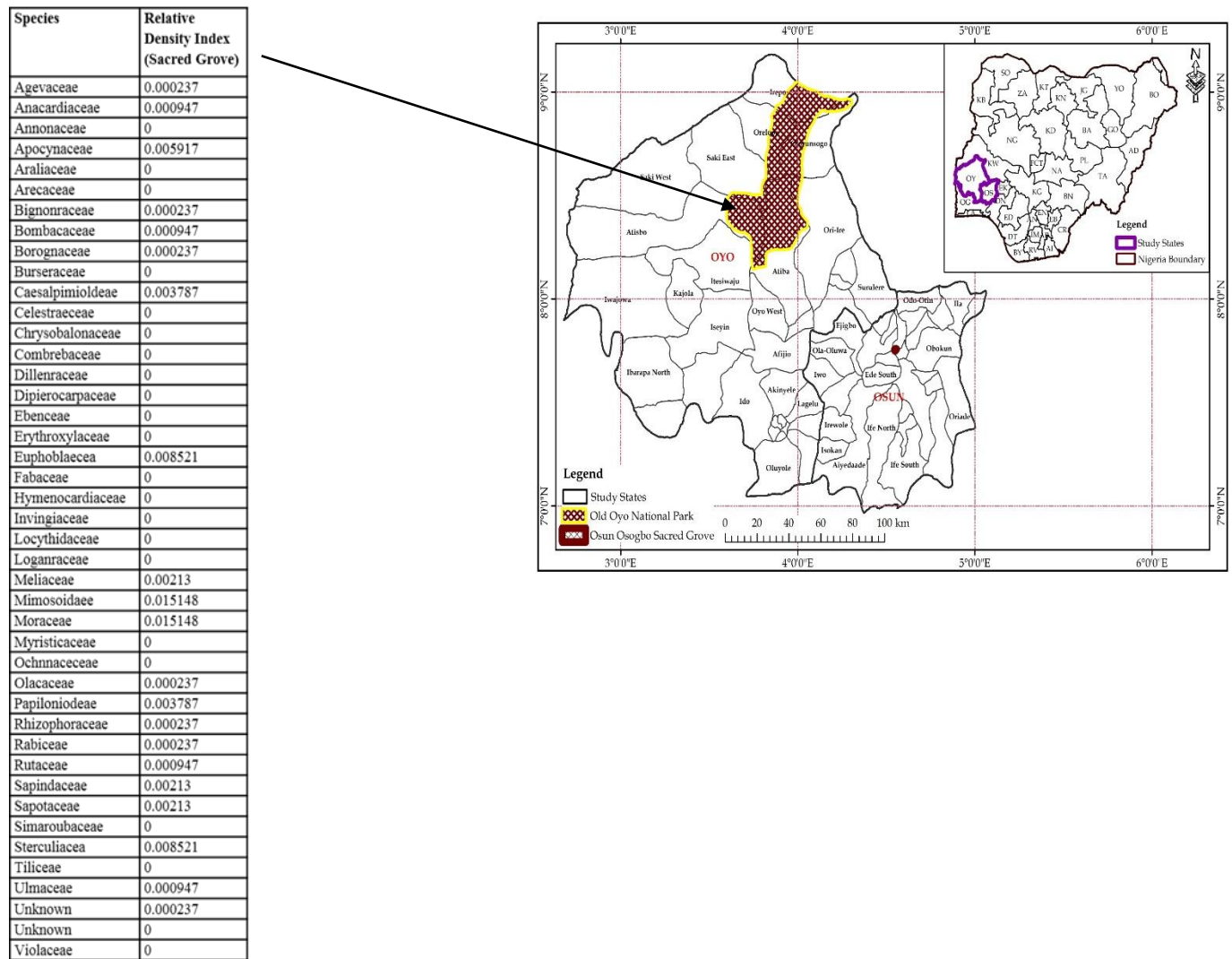


Figure 4.2: Map of OONP showing the tree Diversity

The discriminant model generated was used to determine the factors which distinguished different types of approaches on the basis of surveys. The results of this analysis is similar to a related studies carried out by Raez (2004) and (2017) where a similar principles was adopted in order to define groups of different tree species groups in Amazon basin and the results of the canonical correlations for the dimension one and two are 0.72 and 0.49, respectively.

Consequently, the map in Figure 4.3 represents the belief systems in the two study sites. Osun grove representing the indigenous knowledge system in forest biodiversity protection and management as positioned by the respondents whereas the Old Oyo National park epitomizes the modern biodiversity preservation and management approach that is modern knowledge based.

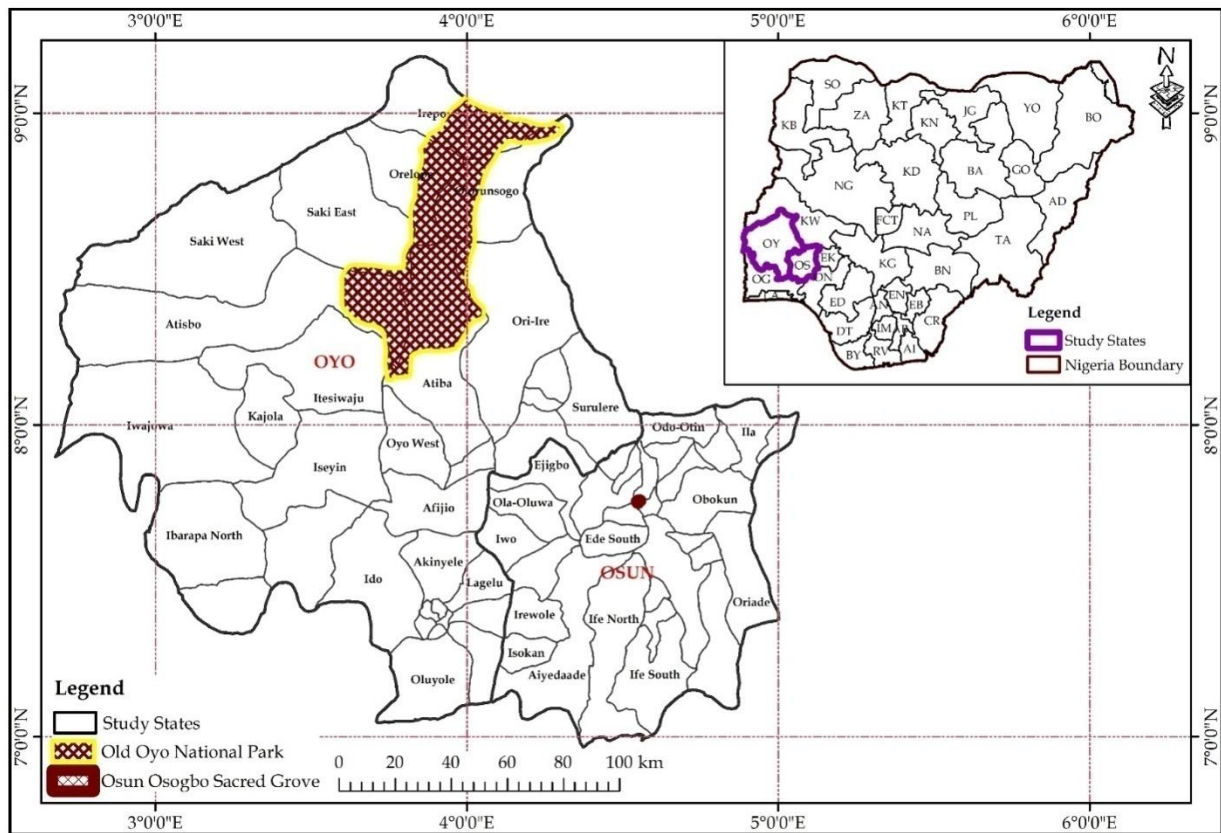


Figure 4.3: Map of the two areas based on the adoption of the two knowledge systems

CHAPTER FIVE

IMPACT OF INDIGENOUS AND MODERN FOREST CONSERVATION METHODS

5.0 Introduction

In general terms, biodiversity evaluation is the process of measuring the value of biodiversity components, such as the number of species present, the population of a species, a habitat (usually meaning a vegetation community) or the sum of all such components within a given area or site. Such evaluations may be carried out for a variety of reasons. For instance, it may be for conservation priority setting, or as part of Biodiversity Action Plan (BAP) development, and a host of other factors. Evaluations may be carried out on various components of biodiversity (i.e. from genetic variation within species, to individual species, species assemblages, species abundance, species evenness and at a variety of scales, from specific sites, to areas, regions, countries, biogeographical areas (although these may be smaller than countries) and globally).

A wide range of potential biodiversity values may be considered, including intrinsic and socio-cultural values and more direct socio-economic benefits such as food, building resources, medicines and waste decomposition and others. A diversity index is a mathematical measure of species diversity in a community. It provides more information about community composition than simply species richness. Evidently from these results indicate that the species diversity, abundance and evenness in this study sites from the undisturbed and primary forest habitat of Osun Osogbo Sacred grove 'Igbooro' an indigenous based *in-situ* conservation area are much higher than the site from the secondary forest in Old Oyo National Park (Plate 5.1-5.4).

The sacred grove not only has a greater number of species present, the individuals in the community are distributed more equitably among these 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 *agavaceae*, *moraceae*, *apocynaceae*, *caesalpiniaceae*, and *euphorbiaceae* while *euphorbiaceae*, is the most common species in the sacred grove, and makes up about 14% of the community. Other species family in Osun Osogbo grove include *mimosaceae*, *apocynaceae*, *ulmiaceae*, *sterculiaceae*, among others. However, the two knowledge systems are aimed at preserving forest biodiversity and how diversity is impacted upon by the two forest management strategies. The results of these are discussed in 5.1 and 5.3 in the following sections.

5.1 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. This result is similar in related studies on sacred sites in Nigeria, Sierra Leone, Ghana and India (Mgumia and Oba, 2003; Savadogo, Mulua and Sawadogo, 2007; Hens, 2006; Onyekwelu and Olusola 2014).

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 include *mimosaceae*, *apocynaceae*, *ulmiaceae*, *sterculiaceae*, among others (See Figure 4.3).

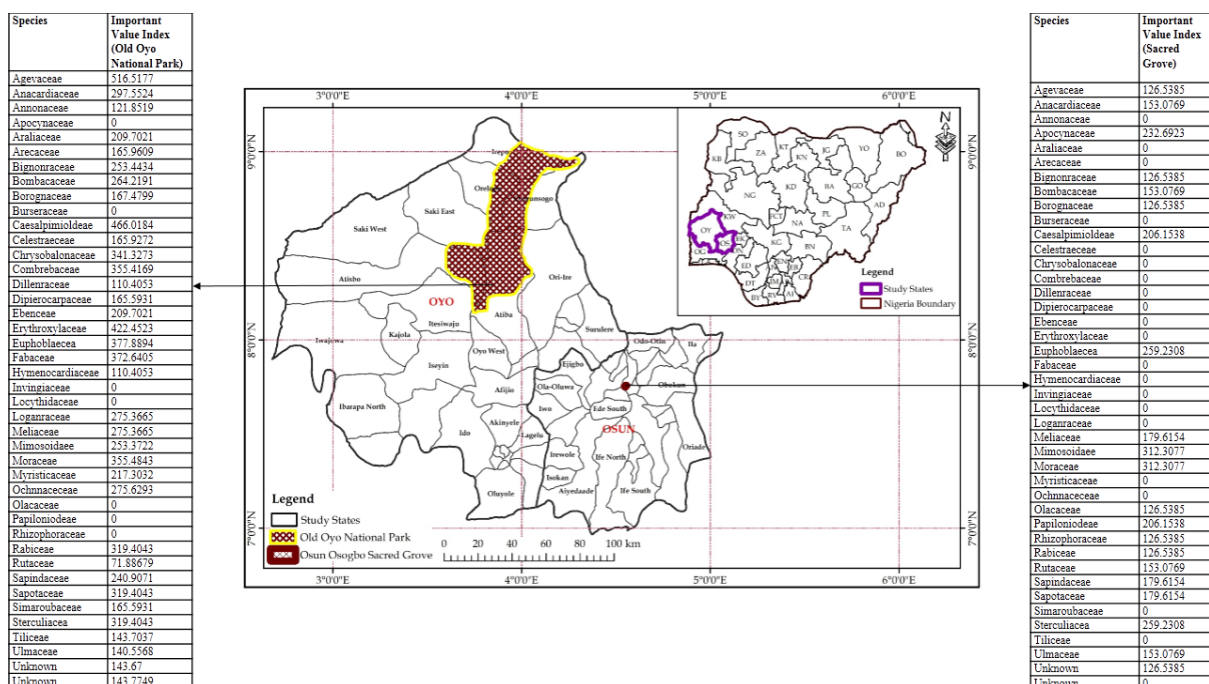


Figure 5.1: Map of OONP and the Grove and the Tree Diversity

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 (Table 5.1). Basal area ranged from 66 to 18.9 m² ha⁻¹ and was significantly different between the sites. The largest individual trees were encountered in Osun Osogbo grove, followed by OONP's degraded forest.

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 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 were subjected to statistical analysis after the exponentials ($\exp. H'$) were computed.

Members of *Sterculiaceae*, *Moraceae*, *Euphorbiaceae*, *Apocynaceae*, *Caesalpiniaceae*, *Ebenaceae*, *Agavaceae* and *Mimosoidaceae* families were dominant in the two ecosystems while members of *Burseraceae*, *Irvingiaceae*, *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 (2006) and Onyekwelu *et al.* (2008), Onyekwelu and Olusola (2014) but higher than the values of Nath *et al.* (2005). 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 (Mgumia and Oba 2003). The non-significant species evenness values for all sites suggested that trees species distribution was similar in all the sites (See Fig 4.1 and Fig 4.2)..

A higher number of tree species has been reported in some sacred groves in Sierra Leone and Kerala, India than in Osun Osogbo (Lebbie and Guries 1995, Rajendraprasad *et al.*, 1998). 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⁻¹ (Adekunle and Olagoke 2008, Onyekwelu *et al.* 2008). Members of *Meliaceae*, *Sterculiaceae*, *Ulmaceae*,

Euphorbiaceae and *Apocynaceae* dominate Nigerian rainforests (Adekunle and Olagoke 2008, Onyekwelu *et al.*, 2008). *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 (Table 5.1) is another indication of their important role in *in-situ* biodiversity conservation, which is in agreement with some published results (Colding and Folke 1997; Mgumia and Oba 2003; Onyekwelu and Olusola 2014).

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.

Table 5.1: Tree Parameters Indices from the Study Sites

Biodiversity Characteristics	Index/tree	Sacred Grove (Indigenous Knowledge) Osun- Osogbo	National Park (Modern Knowledge System) OONP
No. of tree families		20ab	29a
No. of tree species (richness)		62a	31ab
No. of seedling species		65	52
No. of Endangered species		18	14
Diversity Index (H')		3.48a	3.14
Species Evenness (E ₀)		0.65a	0.58b
Mean basal area (m ² ha)		42.5	86.4
Mean dbh (cm)		28.4	15.1
Maximum dbh (cm)		158.8	117.2

Source: Author's Computation, 2018

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 ($P < 0.05$).

5.2. 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 those of Osun- 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 (See Table 5.1). 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 *agavaceae*, *moraceae* *apocynaceae*, *caesalpiniaceae*, and *euphorbiaceae* while *euphorbiaceae*, 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 (2002) in the same area.

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 (2014), which stated that in the whole southwestern, apart from Queen's forest in the 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.

Table 5.2: List of Five Dominant Tree Species in each of the Study Ecosystems

Family	Species	Frequency	Conservation Status	Mean dbh (cm)	RDo (%)	RD (%)	IVI
<u>Osun Osogbo Sacred Grove</u>							
1.Euphorbiaceae	<i>Ricinodendron neudolotii</i>	12	Endangered	27.2	2.92	4.58	3.52
2.Mimosoideae	<i>Allizia Zygic</i>	10	-	41.5	5.36	4.78	5.12
3. Apocymaceae	<i>Helarrhena</i>						
	<i>Floribunda</i>	26	-	24.8	5.37	12.05	8.27
4. Ulmaceae	<i>Cellis Zenkeri</i>	20	-	29.2	6.48	18.75	3.76
5. Sterculiaceae	<i>Cola millenii</i>	21	-	19.2	2.65	10.08	6.18
<u>Old Oyo National Park</u>							
			-	18.2	5.02	11.47	5.64
1. Agavaleae	<i>Allizia Zugia</i>	28	-	20.1	3.48	4.01	3.48
2.Apocynaceae	<i>Alstonia</i>	18	-	15.4	2.63	3.87	6.75
3.Caesalpimioldeae	<i>boonei</i>	14	-	16.4	3.97	9.35	7.12
4. Moraceae	<i>Diaspyros</i>	12					
	<i>Myrianthius arborius</i>		Endangered	21.7	2.02	3.98	3.01
5.Euphoblaeae	<i>Rianodendron herudolotii</i>	06					

Source: Author's Fieldwork (2017)

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 (Table 5.2).

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 (See Table 5.2). This result is in agreement with the reports of Onyekwelu and Olusola, 2014; Mgumia and Oba, 2003; and Hens, 2006). The prevalence of endangered species in Osun grove more than that of OONP, could therefore be used to promote *in-situ* conservation of endangered species.

In comparing the species composition in the two sites, there was a total of 101 seedling species (see the map showing the distribution in Figure 4.3). 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) *Myrianthus 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*, *Sterculiaceae* (26, 21, and 20 species respectively) occurring in Osun Osogbo, while *Agavaceae*, *Caesalpinioideae*, *Apocynaceae* occurring in OONP 28, 18 and 14 species correspondingly were taxonomically diverse and made up the largest groups of taxa in especially Osun grove and the five sectors in OONP (Figure 6.1).

Furthermore, *Apocymacaeae* had the highest IVI owing to the high density of its constituent species *Holarrheaa florimida* for Osun Grove and *Agavaleae* with its basic species *Allizia Zygia*. Families such as *mimosoidaeae*, *euphorbiaaceae* *moraceae* were encountered only at sampled sites in Osun 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.

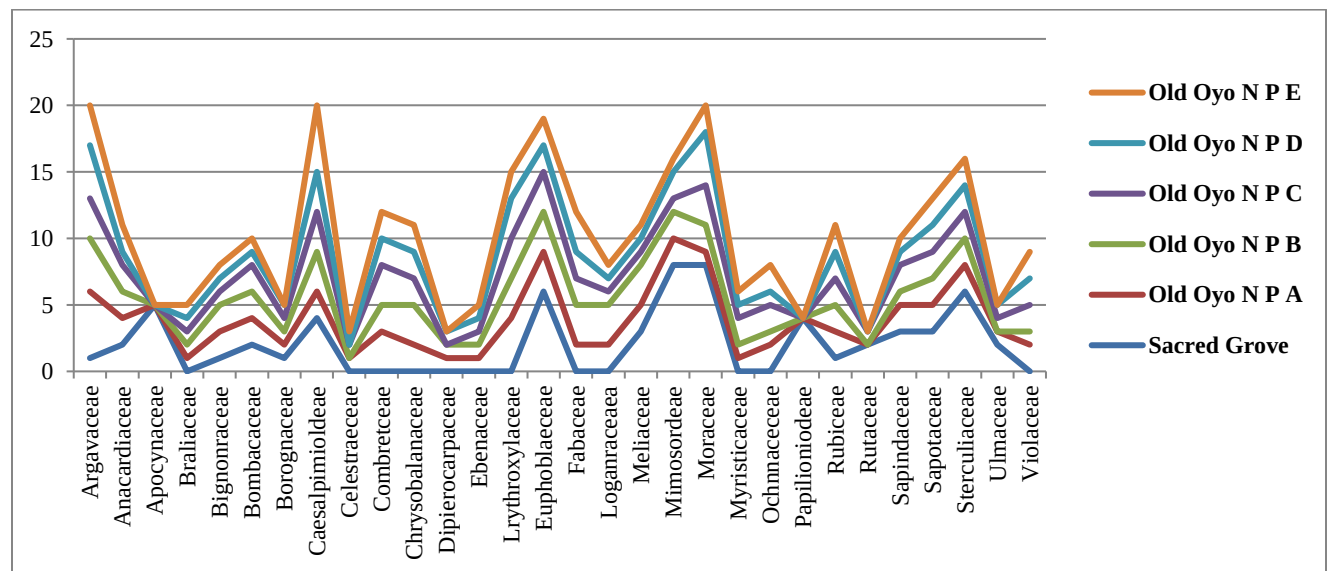


Figure 5.2: Relationship between the Species Families in Osun Grove and the OONP

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 OOG. 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 (*Guenon cercopithecus erythrogaster*) monkey (See Plate 5.1), birds, snakes, and other reptiles, forest antelopes, squirrels and amphibians. This result is compatible with that of Babalola (2014) in the same location. Also there are wild water species including *Napoleona vogelli*, *Aframomum danielli*, *Crinum jagas*, and *Denettia tripetata* among others which were prevalent in the grove.



Plate 5.1: White Throated Monkey found in Osun Grove.

Similarly, the vegetation of the OONP include dense woodland and forests outlier in the southeastern part, mixed open savanna woodland in the central part, outcrop vegetation in the northeast and riparian grassland and fringing woodland occupying the forest plains and valleys along the Ogun River. Some of the species found and identified in OONP which symbolizes the scientific and modern forest biodiversity knowledge system of conservation are shown in Table 5.4 and 5.5 respectively. Among the plant species identified in Osun grove which exemplifies indigenous based knowledge systems of biodiversity conservation are listed in Tables 5.3 and 5.4. It is worth mentioning that the grove is rich in tropical diversity and this comprises trees,

shrubs, herbs, undergrowth and climbers and some invasive species, some of the known species include *Allizia* *Zugia* *Alstonia boonei* *Diaspyros* *Myrianthus arborius* *Rianodendron herudolotii*.

Moreover, the wooded species house Ungulate species sighted during the study were seven which include Kobs (*Kobu kob*), Waterbuck, (*Kobus defassa*), bushbuck, (*Tragelaphus scriptus*) Oribi (*Ourebia Ourebi*), Roan antelope (*Hippotragus equinus*), duiker (*Silvicapra grimmia*) and buffalo (*Syncerus caffer*) and amphibians. This result is similar to that of Ayodele (1988); Tijani (2007), Oladeji *et al.* (2012) and Onyekwelu *et al.*(2014).

Table 5-3: Plant species Recognized in the Osun Osogbo Sacred Grove, Southwestern Nigeria

S/N	Species	Family	Local Name	Life Form
1	<i>Acanthus montanus</i>	Acanthaceae	Ahon-Ekun	Herb
2	<i>Adenia cissampeloides</i>	Passifloraceae	Arokeke	Tree
3	<i>Afzelia Africana</i>	Cesalpiniaceae	Apa	Tree
4	<i>Alchornea laxiflora</i>	Euphorbiaceae	Ijan	Shrub
5	<i>Allophyllus africanus</i>	Sapindaceae	Eekan-choro	Tree
6	<i>Anchmanes difformis</i>	Araceae	Ogrisako	Herb
7	<i>Antiaris toxicaria</i>	Moraceae	Ooro	Tree
8	<i>Aristolochia ringes</i>	Aristolochiaceae	Akogun	Climber
9	<i>Baphia nitida</i>	Papilionaceae	Irosun	Tree
10	<i>Blepharis maderaspatensis</i>	Asteraceae	Ojusaju	Herb
11	<i>Bilighia unijugata</i>	Sapindaceae	Isin-oko	Tree
12	<i>Bombax bundue</i>	Bombacaeae		Tree
13	<i>Brachystegia eurycoma</i>	Caesalpiniaceae	Ako	Tree
14	<i>Carpolobia lutea</i>	Polygalaceae	Osusun	Shrub
15	<i>Celtis-zenkeri</i>	Ulmaceae	Ita	Tree
16	<i>Centrosema pubescens</i>	Papilionaceae	Ewu ahun	Climber
17	<i>Chamanthera depends</i>	Menispermaceae	Atoo	Climber
18	<i>Cissanipelos mucronata</i>	Menispermaceae	Jenjoko	Climber
19	<i>Cissus petiolate</i>	Vitaceae	Daiko/Dekodeko	Climber
20	<i>Cissus quadrangularis</i>	Vitaceae		Climber
21	<i>Cinestis ferruginea</i>	Connaraceae	Omu-aja	Shrub
22	<i>Cola millenii</i>	Sterculiaceae	Obi-edun	Tree
23	<i>Combretum bracteatum</i>	Combretaceae	Ogandudu	Climber
24	<i>Dioscorea bulbiteria</i>	Dioscoreaceae	Emina	Climber
25	<i>Dioscorea mangelotiana</i>	Dioscoreaceae	Esusu	Climber
26	<i>Entada abyssinica</i>	Mimisaceae	Ogunbere	Climber
27	<i>Gliricidia sepium</i>	Papilionaceae	Agunmaniye	Tree

28	<i>Grewia mollis</i>	Tiliaceae	Ora-igbo	
29	<i>Holarrhena floribunda</i>	Apocynaceae	Ako-ire	Tree
30	<i>Hoslundea opposita</i>	Lamiaceae	Ana-mi-ole	Tree
31	<i>ICACINA trichantha</i>	ICACINACEAE	Gbegbe	Shrub
32	<i>Landolphia owariensis</i>	Apocynaceae	Panukuru	
33	<i>Lannea welwitschii</i>	Anacardiaceae	Opon	Tree
34	<i>Lecaniodiscus cupaniode</i>	Sapindaceae	Akika	Tree
35	<i>Limdackeria dentate</i>	Flacourtiaceae	Ooya-edun	
36	<i>Malacantha alnifolia</i>	Sapotaceae	Akala	Tree
37	<i>Microdesmis puberula</i>	Pandaceae	Arinyo	Tree
38	<i>Microdesmis puberula</i>	Pandaceae	Arinyo	Tree
39	<i>Milicia excels</i>	Moraceae	Iroko	Tree
40	<i>Milletia thonningii</i>	Papiilionaceae	Ito	Tree
41	<i>Mondi whitei</i>	Asclepiadaceae	Isirigun	Climber
42	<i>Mondora tenuifolia</i>	Anonaceae	Lakusin	Tree
43	<i>Mucuna purens</i>	Pipilionaceae	Yerepe	Climber
44	<i>Napoleonea vogelii</i>	Lecythidaceae	Ito	Tree
45	<i>Nesogordonia papaverifera</i>	Sterculiaceae	Opepe ira	Tree
46	<i>Newbouldia laevis</i>	Bignoniaceae	Akoko	Tree
47	<i>OlaX subscorpioidea</i>	Olacaceae	Ifon	Shrub
48	<i>Pepperomia pellucida</i>	Piperaceae	Rinrin	Herb
49	<i>Pouzolzia guineensis</i>	Urticaceae	Aboloko-piran	Tree
50	<i>Ricinodendron heudelotii</i>	Euphorbiaceae	Epuu	Tree
51	<i>Rothmannia hispida</i>	Rubiaceae	Dandoje	Tree
52	<i>Solenostemon monostachyus</i>	Lamiaceae	Olojongbodu	Herb
53	<i>Spondias mombin</i>	Anacardiaceae	Iyeye	Tree
54	<i>Sterculia tragachantha</i>	Sterculiaceae	Alawefon	Tree
55	<i>Terminalia ivorensis</i>	Combretaceae	Idigbo	Tree
56	<i>Tragia benthamianum</i>	Euphorbiaceae	Yeesi dudu	Climber
57	<i>Trichillia edulotii</i>	Maliaceae		Tree
58	<i>Triplochinton scleroxylon</i>	Sterculiaceae	Arere	Tree
59	<i>Zanthoxylum xanthoxyloides</i>	Rutaceae	Ata	Tree

Source: Author's Field Survey (2017).



Plate 5.2: Some of the Plants Species cited in the Osun Grove

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 southwest Nigeria (Table 1). 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 (Table5.4) 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 (Table 6.3).



Plate5.3: Osun Grove, Delineation of Transect Lines with Field Assisstants (2017)



Plate5.4: Diameter Breast Height (cm) and Height measurement (m) in one of the sampled Plot in the Grove

CHAPTER SIX

RELATIONSHIP BETWEEN THE TECHNIQUES OF INDIGENOUS KNOWLEDGE SYSTEM AND MODERN FOREST BIODIVERSITY CONSERVATION

6.1 Techniques of Indigenous Knowledge System in Osun Grove

Majority of the respondents posited that traditional practices are more effective through their functions in sustaining biodiversity resources in the grove. In table 4.5, about 74.53 % strongly agree that the use of taboos is an effective tool in sustaining forest biodiversity in the grove. Similarly, myths (87.58%), superstitions (87.58%) and traditional rules (81.37 %) respectively are considered as traditional tools for achieving conservation of biodiversity resources in Osun grove for centuries (See Table 6.1).

Table 6.1: Indigenous Knowledge Systems Technique for Biodiversity Sustenance in Osun Grove

Techniques	Strongly Agree		Agree		Partially Agree		Disagree		Strongly Disagree	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Taboos	125	74.53	34	19.88	2	1.24	4	2.49	3	1.86
Myths	143	87.58	18	9.84	4	2.49	0	0	0	0
Superstitions	153	87.58	12	12.42	0	0	0	0	0	0
Traditional Rules	131	81.37	27	16.77	2	1.24	1	0.62	0	0

Source: Author's Survey (2017)

For example, the study found that there are restrictions on fishing, felling or cutting of trees and penalties for the offenders from traditional rules and taboos have significantly contributed to sustainable management and use of biodiversity in the grove. Evidence has also shown, as revealed by more than 90% of the respondents, that indigenous conservation regulations such as hunting of adult and male animals and restriction of hunting of wild animals throughout the

seasons have been contributing to conservation of biodiversity. This implies that restrictions of fishing in the grove as a mark of respect to Osun deity - the Water goddess, felling and cutting of trees and hunting of animals had a conservation ideology; otherwise those restrictions could not have been in place at all. The indigenous knowledge system, like the modern knowledge system, has its tremendous influence on conservation of forest biodiversity and this has been successful. Therefore, it should not be disparaged owing to its sustainability (Table 4.6).

The protection of the sacred grove from utilization, exploitation and use, explicitly encourages conservation of forest biological diversity and other genetic resources. About 97.8 percent of the respondents confirmed that people were not allowed to extract flora and fauna products from the sacred forest in Osun Osogbo grove. However, all the respondents, 100 percent, affirmed inclination of cultural and religious activities in the sacred grove. A number of resources protected in the sacred grove are rare plants and animals, species coupled with the customs and beliefs of the people. Forbidden areas and totemic items/objects associated with worship immensely promoted the conservation of forest resources such as igbo Oro and many shrines in the grove.

In understanding the instruments underlying indigenous knowledge actions that are biodiversity related, factors such as abomination (18.7%), offer of sacrifice for tree felling (16.1%), taboos and superstition (30.4 %), strict nature preservation (30.4 %) as well as religion value (4.4%) respectively play important role. The respondents were aware of these traditional methods of biodiversity conservation which were passed on from one generation to another generation (oral tradition) through parents, clients and community leaders, For example, tree felling within Osun Osogbo grove is regarded as an abomination and where trees must be felled,

sacrifices must be offered to Osun goddess. Therefore, due to the fear of Osun goddess, the people refrain from felling trees within the grove (Table 4 5).

Table 6.2: Instruments Underlying Indigenous Knowledge Actions that are Biodiversity Related

Factor	Frequency	Percentage	Cumulative Percentage
Abomination	30	18.7	18.7
Offer of sacrifice before felling tree	26	16.1	34.8
Taboos and Superstition	49	30.4	65.2
Nature Preservation	49	30.4	95.6
Religion value	7	4.4	100
Total	161	100	100

Source: Author's Fieldwork, 2018.

6.2 Techniques of Modern Knowledge System in Old Oyo National Park

The Park management has adopted several techniques as attested to by the respondents and top park officials in the sampled settlements of Old Oyo National Park were presented in Table 4.6. Among the array of the techniques employed in forest biodiversity conservation in OONP highlighted, legal protection was most chosen by about 32.4 percent of the respondents. The establishment of buffer zone in the Park was also chosen (27.7%) as key technique used to prevent any form of encroachment and other human activities in the OONP while 23.2 % chose strict nature preservation as a conservation strategy. About 4.4% of the respondents are however indifferent and are of the opinion that not allowing lumbering activities alone is the tool for forest biodiversity conservation technique.

The implication of legal protection is a management practice that is involved with complete natural reserve (flora and fauna resources). This technique represents the maximum level of conservation in the OONP. It is however one thing to understand this technique but another thing is to support the conservation goals. Likewise, the creation of buffer zone is also known as support zone community programmes with emphasizes on provision of key development activity around the OONP. This has shown that legal protection alone is not enough to ensure effective forest biodiversity conservation in the area.

The OONP like many other protected areas suffer from encroachment by harvesting timber, farming, animal husbandry. Therefore, the objective of forest biodiversity conservation can only be ensured by the creation of substantial areas of natural forests for production around them. Such a buffer zone has the responsibility to support the Park area while at the same time, provide the Park's local communities with alternative livelihood.

In OONP, the conservation management approach employed as indicated by the Park senior officials is the mixed top-down and bottom-up approach. The approach entails the application of 'carrot' of public benefits and a 'stick of regulations and enforcement in the villages and communities bordering the Park. The Park management, in order to ensure local communities participation and benefits at a time, introduced the support zone community programme which placed considerable emphasis on livelihoods such as agricultural extension services and employment of indigenous people. In accordance with conservation objectives, the priority in which development assistance was to be provided to support zone villages was based on the proximity to, and perceived on the area constituting the Park. This result was similar to some of the previous studies such as Alarepe (2003); Tijani (2007) and Oyeleke *et al.* (2015).

Generally, the research results showed that Osun Osogbo sacred grove, an indigenous conservation technique, supported more species turnover than the modern and scientific managed forest and wildlife preservation in OONP. Though the two sites have biodiversity significance in terms of the critical forest resources found, the sacred grove, based on the evidence, contributes more to protection of environmental resources than the OONP. A variety of conservation methods have been used to protect forest biodiversity loss and encourage natural regeneration in both the Osun Osogbo grove and OONP in Nigeria (See Table 6.3 for techniques adopted in the preservation and management of OONP).

Table 6.3: Modern Forest Biodiversity Conservation Techniques in OONP

Factor	Frequency	Percentage	Cumulative Percentage
Legal protection	122	34.2	34.2
Establishment of buffer zone	99	27.7	61.9
Co-management/Incentives	17	4.8	66.7
Nature Preservation	83	23.2	89.9
Not allowing lumber extraction	36	10.1	100
Total	357	100	

Source: Author's Fieldwork, 2018.

For instance, in this study, it was observed that a greater woody species diversity and richness in Osun sacred grove (an indigenous forest conservation approach) is more than the state-managed Old Oyo National Park, in spite of the relatively small hectares it occupied. However, this was largely due to the high restrictions of human access by the chief priest locally known as Yeye Osun and other indigenous institutions as well as customary rules from

exploiting the forest and animal resources and causing disturbance in the process. Though Osun Osogbo sacred grove was not created for biodiversity conservation, its complex sociocultural and spiritual associations with deities and spirits of dead ancestors have contributed to the protection of some ecosystems, hence its high biological biodiversity.

Table 6.2 reveals that Osun sacred grove was established and has been in existence for religious and spiritual purposes. Its preservation plays an important role in *in-situ* biodiversity conservation. This is supported with IUCN (2005) that the grove has higher species diversity with mature, fairly undisturbed forest canopy, which supports a rich and diverse flora and fauna. About 70% of Osun Osogbo grove is primary forest (IUCN 2005).

Table 6.4: Indigenous Techniques Related to Preservation and Conservation of *in-situ* Forest Biodiversity in Osun Grove

Indigenous Practices	Sacred Grove Custodians	Community Leaders	Local People
Sacrifices offered	1.Devotees worship everyday 5 days – (10 worship points identified). 2. Presence of Shrines 3. Spiritualism, worship and symbolism 4. Harbours temples rocks, trees, animals and river	1.Institution of traditional religion and belief system (metaphysical and physical) 2. Worship points 3. Festival	1.Abode of a river goddess- OSUN 2.Sacrilege for anyone to kill any ‘‘child’’ 3.Harbours structures, 4.Shrines (40 in numbers) 5. Palaces (2) were identified Sacred Places (5 points were identified) people bring offerings to the goddess
Customary taboos	1.Promotes spiritual value, norms and myths 2. Traditional laws 3.myths 4.customs	Provide traditional protection and rights	Considered as the home of over 200 species of medicinal plants
Traditional Sanctions	1. Rituals and pilgrimage procession 2. Invoking the anger of the spirits	1. Cultural sanctions 2. Presence of objects, gods and places of worship	1. Fear of deities and spirits 2. Atonement or outright banishments
Religious	1. Initiation of priests and	1. Membership of	1. Repository of the tangible

Value	priestesses	cults (Ogboni)	and intangible cultural heritage of the people
			2.place of important community festival

Source: Author's Survey, 2018

The evidence that sacred groves contain high species diversity and richness may support the consideration of conservationists for promoting sacred groves for in-situ biodiversity conservation (Uluocha, 2015).

The whole categories of our interviewees agreed that there is prevalence of endangered species in Osun sacred grove, and that they could be used to promote in-situ conservation of endangered species. Sacred groves are repositories of rare and endemic species. The respondents such as the custodian of the grove -Yeye Osun buttressed the point that under the sacred grove system, forest preservation is secured, using taboos, cultural and religious beliefs through dedication of the forest to deities. Through high opinion and fear of the taboos and deity, people keep away from the sacred grove for hunting, fishing, felling trees, and gracing.

At the focus group discussion (FGD) about 90% respondents claimed that the sound conservation status of Osun Osogbo grove can be attributed to the way people interact with it. For example, people perceive the grove as home of deity (Osun goddess), place of worship, historical and cultural site, which suggest that they hold the grove in high esteem and they are committed to its preservation. In a related study in Tanzania, sacred groves are preserved for worship purpose and protected from exploitation, while removal of plant parts requires ritual performance (Mgumia & Oba 2003). Tree felling within Osun Osogbo groves is regarded as an abomination and where trees must be felled, sacrifices must be offered to Osun goddess. Thus, due to the fear of Osun goddess, the people refrain from felling trees within the grove. The grove

is being protected against overexploitation by sanctions and taboos associated with some spirits and deities and only certain groups of people are allowed access (Lebbie & Guries 1995, Rajendraprasad et al. 1998; Babalola, 2014; Onyekwelu and Olusola, 2014). Fishing and hunting for games in the grove is out rightly prohibited to ensure ecosystem stability. There is penalty for offenders.

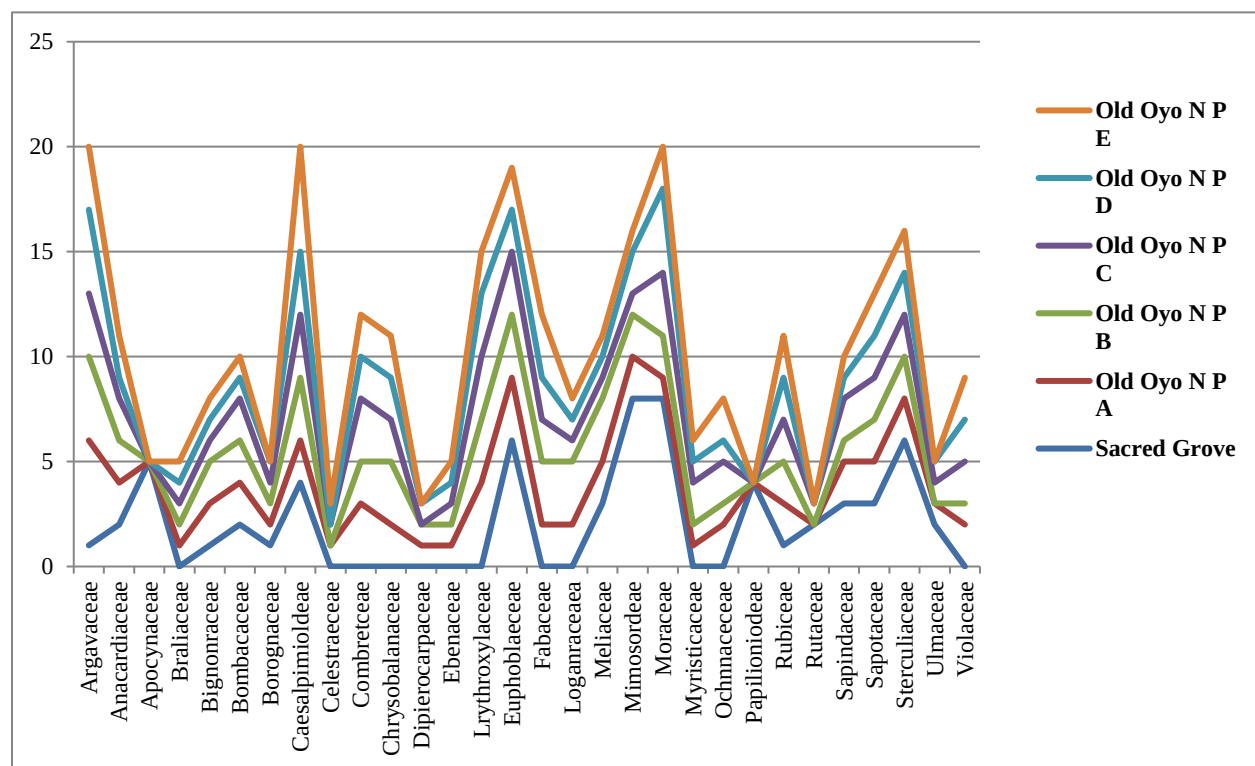


Figure6.1: Relationship between the Species Families in Osun Grove and the OONP

The implications of this analyses 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.



Plate 6.1: Diameter Breast Height (DBH) (cm) and Height Measurements (m) at Oyo Ile Range OONP in one of the delineated sampled plots

On the other hand, the modern knowledge system through the park system with the ultimate objective of protection of biological diversity, conservation is also effective, except in some boundary and buffer zones where anthropogenic activities such as farming, illegal hunting and charcoal production are going on though with the goal of allowing some degree of human

activities. The OONP was established to protect and mainly to preserve biodiversity and other natural formations. Though it allows some degree of human use and controlled exploitation, this is not without some threats to the Park posed by local people's activities.

A total of 200 individuals species were recorded in Osun Osogbo sacred grove with 65 flora species identified (See list of flora species occurrences in the Grove in Table 6.5). They belong to 39 families and have the highest species occurrences – *Apocynaceae*, *Ulmaceae*, *Sterculiaceae*, *Ulmaceae*, *Mimosoidaceae*, *Euphorbiaceae* while twenty-one families have the slightest species occurrences (1) – *Asclepiadaceae*, *Urticaceae*, *Maliaceae* among others. In the five sampled ranges in OONP, 35 species of woody species belonging to 27 families were identified as family *Agavaceae* (28) *Albizia zigia*, *Albizia ferruginea*, *Azalia Africana*.

Table 6.5: Plant species identified in the Osun Sacred Grove, Osun State Nigeria

S/N	Species	Family	Local Name	Life Form
1	<i>Acanthus montanus</i>	Acanthaceae	Ahon-Ekun	Herb
2	<i>Adenia cissampeloides</i>	Passifloraceae	Arokeke	Tree
3	<i>Azalia Africana</i>	Caesalpiniaceae	Apa	Tree
4	<i>Alchornea laxiflora</i>	Euphorbiaceae	Ijan	Shrub
5	<i>Allophyllus africanus</i>	Sapindaceae	Eekan-choro	Tree
6	<i>Anchmanes difformis</i>	Araceae	Ogrisako	Herb
7	<i>Antiaris toxicaria</i>	Moraceae	Ooro	Tree
8	<i>Aristolochia ringes</i>	Aristolochiaceae	Akogun	Climber
9	<i>Baphia nitida</i>	Papilionaceae	Irosun	Tree
10	<i>Blepharis maderaspatensis</i>	Asteraceae	Ojusaju	Herb
11	<i>Bilighia unijugata</i>	Sapindaceae	Isin-oko	Tree
12	<i>Bombax bundue</i>	Bombacaeae		Tree
13	<i>Brachystegia eurycoma</i>	Caesalpiniaceae	Ako	Tree
14	<i>Carpolobia lutea</i>	Polygalaceae	Osusun	Shrub
15	<i>Celtis-zenkeri</i>	Ulmaceae	Ita	Tree
16	<i>Centrosema pubescens</i>	Papilionaceae	Ewu ahun	Climber
17	<i>Chamanthera depends</i>	Menispermaceae	Atoo	Climber
18	<i>Cissanipelos mucronata</i>	Menispermaceae	Jenjoko	Climber
19	<i>Cissus petiolate</i>	Vitaceae	Daiko/Dekodeko	Climber
20	<i>Cissus quadrangularis</i>	Vitaceae		Climber
21	<i>Cinestis ferruginea</i>	Connaraceae	Omu-aja	Shrub
22	<i>Cola millenii</i>	Sterculiaceae	Obi-edun	Tree

23	<i>Combretum bracteatum</i>	Combretaceae	Ogandudu	Climber
24	<i>Dioscorea bulbiteria</i>	Dioscoreaceae	Emina	Climber
25	<i>Dioscorea mangelotiana</i>	Dioscoreaceae	Esusu	Climber
26	<i>Entada abyssinica</i>	Mimicaceae	Ogunbere	Climber
27	<i>Gliricidia sepium</i>	Papilionaceae	Agunmaniye	Tree
28	<i>Grewia mollis</i>	Tiliaceae	Ora-igbo	
29	<i>Holarrhena floribunda</i>	Apocynaceae	Ako-ire	Tree
30	<i>Hoslundea opposita</i>	Lamiaceae	Ana-mi-ole	Tree
31	<i>Isacina trichantha</i>	Isacaceae	Gbegbe	Shrub
32	<i>Landolphia owariensis</i>	Apocynaceae	Panukuru	
33	<i>Lannea welwitschii</i>	Anacardiaceae	Opon	Tree
34	<i>Lecaniodiscus cupaniode</i>	Sapindaceae	Akika	Tree
35	<i>Limnolobos dentata</i>	Flacourtiaceae	Ooya-edun	
36	<i>Malacantha alnifolia</i>	Sapotaceae	Akala	Tree
37	<i>Microdesmis puberula</i>	Pandaceae	Arinyo	Tree
38	<i>Microdesmis puberula</i>	Pandaceae	Arinyo	Tree
39	<i>Milicia excelsa</i>	Moraceae	Iroko	Tree
40	<i>Milletia thonningii</i>	Papilionaceae	Ito	Tree
41	<i>Mondia whitei</i>	Asclepiadaceae	Isirigun	Climber
42	<i>Mondra tenuifolia</i>	Anonaceae	Lakusin	Tree
43	<i>Mucuna purens</i>	Papilionaceae	Yerepe	Climber
44	<i>Napoleonea vogelii</i>	Lecythidaceae	Ito	Tree
45	<i>Nesogordonia papaverifera</i>	Sterculiaceae	Opepe ira	Tree
46	<i>Newbouldia laevis</i>	Bignoniaceae	Akoko	Tree
47	<i>Olex subscorpioidea</i>	Oleaceae	Ifon	Shrub
48	<i>Peperomia pellucida</i>	Piperaceae	Rinrin	Herb
49	<i>Pouzolzia guineensis</i>	Urticaceae	Aboloko-piran	Tree
50	<i>Ricinus dendron heudelotii</i>	Euphorbiaceae	Epuu	Tree
51	<i>Rothmannia hispida</i>	Rubiaceae	Dandoje	Tree
52	<i>Solenostemon monostachyus</i>	Lamiaceae	Olojongbodu	Herb
53	<i>Spondias mombin</i>	Anacardiaceae	Iyeye	Tree
54	<i>Sterculia tragachantha</i>	Sterculiaceae	Alawefon	Tree
55	<i>Terminalia ivorensis</i>	Combretaceae	Idigbo	Tree
56	<i>Tragia benthamianum</i>	Euphorbiaceae	Yeesi dudu	Climber
57	<i>Trichillia edulotii</i>	Maliaceae		Tree
58	<i>Triplochinton scleroxylon</i>	Sterculiaceae	Arere	Tree
59	<i>Zanthoxylum xanthoxyloides</i>	Rutaceae	Ata	Tree

Source: Author's Survey, 2018

Of this number, 16 species belonging to 14 families had the least occurrences in the 5 ranges in OONP- *Rubiaceae*, *Ammonaceae*, *Hymenocardiaceae*, and *Ebenaceae*. *Celtis zenkeri*

(*Ulmaceae*) was the most dominant species in the two sites with OOG having 53.27% relative abundance and OONP with 34.36 % relative abundance (Table 6.2), Eight species in OOG (e.g. *New bouldia laevis* [Akoko]) and three species in (e.g. *Baphia nitida*, [Irosun] 0.94% RA) were the least recorded. Seven species (e.g., *alchornea laxiflora*, *bombax bundue*, *entada abyssinica*, *Lecaniodiscus cupaniode*, and *Nesogordonia periferia*) occurred in the two sites. The average diameter at breast height (DBH) did not substantially vary between the two sites (t -test = 0.016, $F = 1.14$, $p = 0.9$) and they ranged between 30cm and 117cm (Figure 6.2). The highest DBH was registered in sacred grove (117 cm), while that of OONP was 108 cm.

The average height for OONP ranged between 9m and 20m while that of the sacred grove varies between 12m to 25m. Trees in the grove showed a high regeneration capacity, and this is reflected in the estimated 35 species of diameters < 50 cm. Although the Osun grove is composed of mature trees, with ≤ 90 –117cm DBH, only 19 trees were found within this range (Figure 6.2). There was a significant relationship between tree diameter and basal area in Osun Osogbo ($r = 0.975$, $U=0$, $z = -8.258$, $p < 0.0001$, Mann–Whitney U test) and OONP ($r^2 = 0.937$, $U = 0$, $z = -13.67$, $p < 0.0001$).

Species diversity did not differ significantly in each site: OONP (*one-way ANOVA test*, $F = 0.29$, $p > 0.05$) and Osun Osogbo sacred grove ($F = 0.38$, $p = 0.5$). The probability of 5% was used in the variables. However, an overall comparison of the two sites showed significant variations (t -test = -4.6 , $p = 0.002$).

The noticeable similarity in species evenness distribution in the two habitats was possibly due to the spatial patterns of stands that enable them to effectively utilize environmental resources like sunlight, soil fertility and species coexistence from the same functional group.

Variations in basal area could be attributed to differences in age of plants, type of species, ability to compete for limited resources, and other environmental mediating factors in the two habitats.

Similar variations in plant attributes have been reported in sacred groves and forest reserves in Ghana and Tanzania which range from $H = 0.86\text{--}1.56 \pm 0.09$, while that of OONP was $H = 1.43\text{--}2.3 \pm 0.10$. Species richness followed similar pattern like diversity and considerably differed between the two sites ($t\text{-test} = -4.1$, $p = 0.004$) and was in the range $1.1\text{--}2.3 \pm 0.57$ in Osun and $1.8\text{--}3.69 \pm 0.30$ in OONP. In spite of the varied diversity and richness, overall species evenness distribution pattern appeared to be similar in Osun Grove and OONP ($F = 2.55$, $t = 1.15$, $p = 0.14$). Both the distribution of tree species in a sample population (evenness index) and site occupancy of tree species (basal area) were found to be similar at both study sites. However, mean diameters of trees recorded at both sites were significantly different ($p = 0.025$), with Osun grove recording the highest mean diameter of 72.36 cm and OONP 64.75 cm for this study.

The apparent similarity in species evenness distribution in the two habitats was probably due to the spatial patterns of stands that enable them to effectively utilize resources such as sunlight, soil fertility, and species coexistence from the same functional group. Variations in basal area could be attributed to differences in age of plants, type of species, ability to compete for limited resources, and other environmental mediating factors in the two habitats. Similar variations in plant attributes have been reported in sacred groves and forest reserves in Tanzania (Boadi *et al.*, 2017; Mgumia and Oba, 2003) which were comparable with the result of this study.

Overall, positive correlation in tree diameter and basal area in Osun Osogbo and the OONP suggests that differences in conservation approach did not in any way influence resource

availability and equitable utilization among species. This compensatory role of disturbance in ecosystem functioning appears to contribute to harnessing biodiversity integrity in both sites. Secondly, it is thought that the diversity of level of forest biodiversity in OONP, despite its location in the Savannah ecological zone, could be a result of the presence of some edible species, leaf litter, and dead wood/branches, brought about by logging, farming activities, and charcoal making. Thus, their presence and abundance help to speed up the decomposition process of leaf clutter and dead timber, leading to improved soil fertility.

6.4 Conservation of Tree Diversity in OOG

The forest vegetation in the sacred grove is distinctive in the sense that it is barely the remaining relic of the Nigerian rain forest ecosystem endemic to the grove. The *in-situ* forest functions as watersheds, protecting the water body and also accelerates micro climatic conditions within and communities adjoining the sacred grove. Among the flora species identified in the grove are listed in Tables 6.3 and 6.4. 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 (*Guenon cercoplhecus erythrogaster*) monkey, birds, snakes, and other reptiles, forest antelopes, squirrels and amphimbians. This result is compatible with that of Babalola (2014) in the same location. Also there are wild water species including *Napoleona*, *vogelli*, *Aframomum danielli*, *Crinum jagas*, and *Denettia tripelata* among others which were prevalent in the grove.

6.4.1 Conservation of Tree Diversity in OONP

The vegetation of the OONP include dense woodland and forests outlier in the southeastern part, mixed open savanna woodland in the central part, outcrop vegetation in the northeast and riparian grassland and fringing woodland occupying the forest plains and valleys along the Ogun River.

Among the plant species identified in the grove are listed in Tables 6.3 and 6.4. It is worth mentioning that the grove is rich in tropical diversity and this comprises trees, shrubs, herbs, undergrowth and climbers and some invasive species. Some of the known species include *Allizia* *Zugia* *Alstonia boonei* *Diaspyros* *Myrianthus arborius* *Rianodendron herudolotii* (See Table 6.4)

Moreover, the wooded species house Ungulate species sighted during the study were seven which include Kobs (*Kobu kob*), Waterbuck, (*Kobus defassa*), bushbuck, (*Tragelaphus scriptus*) Oribi (*Ourebia Ourebi*), Roan antelope (*Hippotragus equinus*), duiker (*Silvicapra grimmia*) and buffalo (*Syncerus caffer*) and amphibians. This result is similar to that of Ayodele (1988); Tijani (2007), Oladeji *et al.* (2012) and Oyeleke *et al.*(2015).

TABLE: 6.6 Occurrence of Individual Plant Species In the Old Oyo National Park (OONP)

S/N	Species	FAMILIES	Local Name	Life Form
1	<i>Allophylus Africanus</i>	Spaindacea	Eekan-choro	Tree
2	<i>Acacia Ataxacantha</i>	Mimosoideae	Cassia	Climber
3	<i>Acacia Gourmaensis</i>	Mimosoideae	Cassia	Tree
4	<i>Afzelia Africana</i>	Caesalpinioideae	Apa	Tree
5	<i>Albizia Malocophylla</i>	Mimosoideae	Abara	Tree
6	<i>Albizia Zygia</i>	Mimosoideae	Ayinre-weere	Tree
7	<i>Alcornea Cordifolia</i>	Euphorbiceae	Kaju	Tree
8	<i>Anogeisus Leiocarpus</i>	Combretaceae	Ayin	Tree
9	<i>Anthocleista Djalonesis</i>	Loganiceae	Sapo	Tree
10	<i>Antiaris Africana</i>	Moraceae	Ooro,Farinloko	Tree
11	<i>Antidesma Venosom</i>	Euphorbigceae	Ewu ahun	Climber
12	<i>Aphania Senegalensis</i>	Sapindaceae	Atoo	Climber
13	<i>Berlinia Grandiflora</i>	Caesalpinioideae	Jenjoko	Climber
14	<i>Bombax Costatum</i>	Bombacaceae	Daiko/Dekodeko	Climber
15	<i>Bridelia Micrantha</i>	Bombacaceae	Omu-aja	Shrub
16	<i>Bridelia Sceronocera</i>	Bombacaceae	Obi-edun	Tree
17	<i>Burkia Africana</i>	Caesalpinioideae	Ogandudu	Climber
18	<i>Cassia Sieberiana</i>	Caesalpinioideae	Cassia	Tree
19	<i>Clausana Anisata</i>	Rutaceae	Ora-igbo	Climber
20	<i>Cola milleni</i>	Sterculiceae	Obi-edun	Tree

21	<i>Cola nitida</i>	Sterculiaceae	Obi gbajo	Tree
22	<i>Cussonia Arborea</i>	Araliaceae		Tree
23	<i>Dalium Guineense</i>	Anarcardiaceae	Tsamayah Kurmi	Tree
24	<i>Daniellia Oliveri</i>	Caesalpinoideae	Iya, Kadaura	Tree
25	<i>Deterium Microcarpus</i>	Caesalpinoideae	Iya	Tree
26	<i>Deterium Senegalensis</i>	Caesalpinoideae	Iroko	Tree
27	<i>Diospyrous Mespliformis</i>	Ebenaceae	Arin	Tree
28	<i>Entanda Africana</i>	Mimosoideae	Igbanso	Tree
29	<i>Ficus Abulatilifolia</i>	Moraceae		Tree
30	<i>Ficus Capensis</i>	Moraceae	Opoto. farin bauree	Tree
31	<i>Ficus Caprefolia</i>	Moraceae		Tree
32	<i>Ficus Cordata</i>	Moraceae	Asoro	Tree
33	<i>Ficus Exasperata</i>	Moraceae	Epin	Tree
34	<i>Ficus Sycomorous</i>	Moraceae		Tree
35	<i>Ficus Trichopoda</i>	Moraceae		Tree
36	<i>Flacourtia Indica</i>	Flacourticeae	Dandoje	Tree
37	<i>Grewia Moliis</i>	Tiliceae	Ora-Igbo	Climber
38	<i>Haemotosphis Barteri</i>	Anarcardiaceae	Iyeye	Tree
39	<i>Hannoua Undulata</i>	Simaroubaceae	Alawefon	Tree
40	<i>Hexalobus Monopetalus</i>	Annonaceae		Shrub
41	<i>Hymeniocardia Acida</i>	Hymenocardiaceae		Climber
42	<i>Isorbelinia Doka</i>	Anarcardiaceae		Shrub
43	<i>Khaya Senegalensis</i>	Meliceae	Oganwo	Tree
44	<i>Kigelia Africana</i>	Bignonaceae	Pandoro	Tree
45	<i>Lannea Acida</i>	Anarcardiaceae		Tree
46	<i>Lannea Barteri</i>	Anarcardiaceae		Tree
47	<i>Laannea Skimperi</i>	Anarcardiaceae		Tree

	<i>Lecaniodiscus</i>			Tree
48	<i>Cupanioides</i>	Sapindaceae		Tree
49	<i>Lopphinra Lanceolata</i>	Ochnaceae		Tree
50	<i>Macrosphyra Longistyla</i>	Rubiaceae		Tree
51	<i>Malacanthia Alnifolia</i>	Sapotaceae		Tree
52	<i>Maranthes Polyandra</i>	Chrysobalanaceae		Tree
53	<i>Margaritaria Discoidea</i>	Euphorbiaceae		Tree
54	<i>Maytenus Senegalensis</i>	Celastraceae		Tree
55	<i>Milicea Excesa</i>	Moraceae	Iroko	Tree
56	<i>Parkia Biglobosa</i>	Caesalpinioideae	Igba, Dorowa	Tree
57	<i>Pericopsis Laxiflora</i>	Fabaceae		Tree
58	<i>Piliostigma Thonnigii</i>	Caesalpinioideae		Tree
59	<i>Prosopis Africana</i>	Mimosoideae		Tree
60	<i>Pseudocedrela Kotschyii</i>	Meliceae		Tree
61	<i>Pterocarpus Erinoceous</i>	Fabaceae		Tree
62	<i>Pterocarpus Santalinioides</i>	Fabaceae		Tree
63	<i>Pterygota Microcarpa</i>	Sterculaceae	Apapa	Tree
64	<i>Spathodea Campanulata</i>	Bignolaceae		Tree
65	<i>Spondias Mobin</i>	Anacardiaceae	Iyeye	Tree
66	<i>Sterculia Satigera</i>	Sterculaceae	Alawefun	Tree
67	<i>Tamarindu Indica</i>	Caesalpinioideae	Idigbo	Tree
68	<i>Triplochiton Scleroxum</i>	Sterculaceae	Arere	Tree
69	<i>Vitaleria Paradoxum</i>	Sapotaceae	Igi emi	Tree
70	<i>Vitex Chrsocarpay</i>	Verbanaceae	Adabi	Tree
71	<i>Xylophia Parvilora</i>	Annonaceae	Erun Imo	Tree

Source: Authors Survey, 2018.



Plate6.2: The Researcher measuring the dBH at Tede Range of OONP in order to determine the Biodiversity Status



PLATE 6.3: dBH Measurement being taken in one of the Sampled Plot at Sepeteri, OONP



Plate 6.4 : Osun Grove and Igboo Oro inset and rich primary forest stand



Plate 6.5: Researcher and Field Assistants inset in one of the sampled Quadrats in Osun Grove.



Plate 6.6: Rich Forest Biodiversity Status of Osun Grove



Plate 6.8: Measurement of dBH and Height of trees being taken in one of the Quadrat in OONP

CHAPTER SEVEN

FACTORS AFFECTING FOREST BIODIVERSITY CONSERVATION

7.1 Factors Affecting the Success of Biodiversity Conservation Methods in OONP

Old Oyo National Park (OONP) is endowed with flora and fauna resources that have been preserved and conserved for many years. The National Park is rich in abundant tree species for instance the *Mahoganic*, *Nauclea diderrichill* (opepe), *Terminolia Ivorensis* (Odigbo), *Terminolia Superba* (Afara), *Triplochitor Sceleroxylon* (Obeche) and others. Table 4.12 reveals the level of awareness of the existence and contribution of OONP in their areas.

Table 7.1: Respondents' Level of Awareness and Service Rendered by OONP

Responses In %	Tede	Sepeteri	Tessi Koro	Igbo Ologun	Abaja	Dogari Iju	Soro	Ajebadele	Gbodu Ro
Agreed	90	88	85	96	86	87	92	89	88
Disagreed	7	4	13	2	6	3	3	4	6
Do not know	3	8	2	2	8	10	5	7	6
Total	100	100	100	100	100	100	100	100	100

Author's Field Survey, 2018

The study reveals that (90%) in Tede, (88%) in Sepeteri and 96% of respondents were aware of the existence of OONP while 7%, in Tede, 4% in Sepeteri, and 2% in Igbo Ologun in the study area indicated their disagreement of awareness of the OONP and the service it rendered to promotes socio-economic activities in the area. The results in Table 7.1 indicates that majority of the respondents in the study area have knowledge of the existence of OONP. The results show that the conservation of flora and fauna resources in the Park is yielding better result, and yet, considerable efforts is still required to preserve and protect the area against poaching and other unlawful activities.

Management of OONP corroborated the adoption of two main approaches which have contributed to the success of forest biodiversity conservation. The first approach is the preservation approach, which aims at setting aside the park to exclude human activities except tourism. Any form of direct use of natural resources in the park for subsistence and commercial purposes is prohibited. Secondly, the community-based approach involves approach aimed at conserving *in-situ* biodiversity in OONP but also letting local people benefit from park in terms of incentives refers to as community support programme, Some of the initiatives in this approach include infrastructural development, provision of employment opportunities, farming extension service, establishment of health and educational institutions. Table 7.2 reveals the factors identified affecting biodiversity conservation in OONP.

A total of 8 senior members of staff interviewed agreed completely with the identified factors for the success of *in-situ* conservation of forest biodiversity in OONP. The creation of OONP led to displacement of the communities from the land they previously occupied (100%). This also implies creating a better awareness of the conservation objective for the park. Likewise, the local people neighbouring the OONP were restricted from accessing flora and fauna resources in the park over resource use by constantly patrolling and physically guarding the park. The respondents agreed to this (100%).

Table 7.2: Factors Affecting the Success of Biodiversity Conservation in OONP

Factors	Management Staff Frequency n=8	Responses in % Agree	Responses in % Disagree	Responses in % Do not Know	Percentage (%) Total
Creation and Management of the Park	8	100	0	0	100
Local Community Neighbouring the Park	8	100	0	0	100
National Policy governing the Park	8	50	50	0	50
The Area where the Park is located.	8	100	0	0	100

Source: Author's Fieldwork, 2018

To ensure full implementation of conservation objectives, the park administration had conflict resolution mechanisms and also possessed documents for legal establishment of the park. According to the Park management, there is regular education, awareness and outreach programmes to local people neighbouring the OONP usually effected through their leadership structure. The OONP also has a monitoring and evaluation system in place to ensure effectiveness of their duty. All the identified factors ensured the success of the *in-situ* forest biodiversity in OONP. However, government policy governing the operation of the park only contribute 50% to the park .The implication of this is that there is need to review this policy to make it more effective especially the community support programme.

7.2 Human Activities Relating to Biodiversity in Osogbo Sacred Grove

The concept of sacred grove (Igbo Oro) is specifically strong among the indigenous people of Osogbo. This study is concerned about the status of the sacred forest and the loss of forest biodiversity thus the needs to gather information about the local people activities relating to biodiversity conservation.

The next section explains each of the socio-economic activity and forest biodiversity conservation:

7.2.1 Fuel Wood Collection and Forest Biodiversity Conservation

The key source of energy for the people of Osogbo was fuel wood which was used by (82%) of respondents. Other energy sources were charcoal, Kerosene and electricity. Many respondents agreed that fuel wood is the energy source of choice for the reason that it is available in abundance, relatively cheap and easiness of use. About 82% of fuel wood users harvested it from the wild and buffer zone, (16.1%) bought from the market while 3% collects from their farms after burning in preparation for a new farming season. However, there were more than (62%) female fuelwood users than their male counterparts. Above two thirds (75%)) do collect fuelwood between one or two times a week while 27% collects more than twice a week. It was observed that fuelwood types collected were of bamboo (72%) while other types are equally represented (Table 7.3).

Table 7.3: Fuel wood/Deadwood Collection and Forest Biodiversity Conservation

Variables	Categories	Frequency	Percentage (%)
Use of fuelwood as energy	Yes	132	82
	No	29	18
Gender and fuelwood use	Male	58	36
	Female	103	64
Fuelwood harvesting as an Occupation	Secondary	148	92
	Primary	13	8
Source of fuelwood	Harvesting wood		
	From wild	4	2.5
	Collecting from farm	128	79.5
	Buying from the market	26	16.1
	Others	3	1.9
Frequency of fuel wood collection	once/twice a week	121	75.2
	More than once a week	40	24.8
Effect of farming and wood felling on forest biodiversity	Yes	45	28
	No	116	72

Source: Author's Fieldwork, 2018.

7..2.2. Farming and Forest Biodiversity Conservation

Farming as an activity was observed around the buffer zone of the sacred grove on both subsistence level (71.4%) and commercial base (28.6%).It was observed that there were little mechanized farming at the boundary zone of the grove. More than two thirds of the farmers thought that their activities had no effect on the forest resources and wildlife of the area (19.9%).

Table 7.4: Farming and Forest Biodiversity Conservation

Variables	Categories	Frequency	Percentage (%)
Types of farming	Subsistence	115	71.4
	Commercial	46	28.6
Land preparation for	Manual	145	90
Cultivation	Mechanized	16	10
Size of Farms	Small (1-5 ha)	138	86.3
	Large (>5ha)	23	14
Effect of farming/wood	Yes	32	19.9
Harvesting on forest biodiversity	No	129	79.1

Source: Author's Fieldwork, 2018

7.2.3 Osun Osogbo Festival and Biodiversity Conservation

Osogbo community celebrates the annual Osun Osogbo festival (89%) which is well appreciated among the indigenes. Majority of such respondents were more than 40 years of age. Local people of Osogbo community fraternize with other members. This festival has become a major ecotourist attraction in Nigeria which has helped to develop local economy in the study area. About 98% of the respondents claimed of their awareness and importance of Osun Osogbo annual festival for ecotourism and socio-economic development of their community.

Other respondents believe that the festival provides opportunity for conservation of mermaid, flora and fauna while still providing opportunity to thank the gods over the year. It was observed

that the recent difficulty in collecting fuel woods and animal catching were angels of gods and observation of taboos (87%) and environmental degradation (25%) whereas other reason is the experience of Osogbo group and their encroachment of the study site (Table 8.4). Majority of the respondents were aware of indigenous methods of biodiversity conservation such as the introduction of taboo, establishments of sacred groves, shrines, bushes (Igbo Oro) etc. which were passed on from one generation to another (87.6%) (See Table 7.5).

Table 7.5:The Osun Osogbo Festival and Forest Biodiversity Conservation

Variables	Categories	Frequency	Percentage (%)
Membership of Osogbo Community	Yes	132	81.9
	No	29	18.1
Age and Osogbo group Member	More than 40	73	73
	Less than 40	27	27
Reasons for difficulty in felling Trees in recent times	Angels of gods	141	87.6
	Environmental degradation	13	8.1
	Experience of Osogbo group	7	4.3
Importance of Osun Osogbo For ecotourism	Yes	158	93.7
	No		12.4
Awareness of indigenous Conservation (Taboo days, sacred grove)	Yes	141	87.6
	No	20	12.4
Indigenous versus Modern Conservation	Effect of indigenous Conservation	74	46
	Effect of Modern conservation	87	54

Source: Author's Fieldwork, 2017

Most of the respondents also believe that traditional biodiversity conservation was more effective (54%) than modern “western” (46%) which make use of community laws, bye-laws and legislation. Some of the tangible reasons assigned for the apparent effectiveness of indigenous biodiversity conservation were the presence of angels of Osun goddess and other deities, taboos day and other superstitions relating to felling of trees and tampering with other fauna resources in the sacred grove.

7.2.4. Bush Burning and Forest Biodiversity Conservation

During the study period, it was observed that human activities were carried out primarily at the buffer zone; there was no poaching activities in the core zone of the sacred grove. It was around late November and December that vegetation burning was observed in the buffer zone. Almost all the bush fire recorded were human caused out of which (65.2%) were purposely set. Deliberate bush fire were set by hunters (30%) or grazers (16%) and (54%) clearing vegetation on land for cultivation (See Table 4.17). Discarding of cigarette buffs (79.5%) was the main cause of accidental bush fire strictly followed by on-farm cooking. This result was in agreement with that of Wahab *et.al* (2015) in Oboto on the same subject matter. Bush burning in the grove buffer zone was observed to be one of the causative agents with the overall impact on forest biodiversity degradation which is behind most of the degraded tree biomass in the sacred grove.

Table 7.6: Bush Burning and Forest Biodiversity

Variables	Categories	Frequency	Percentage (%)
Bushfires purposely set	Yes	105	65.2
	No	56	34.8
Deliberate fire set	Hunters	48	30
	Grazers	25	16
	Vegetation clearing	88	54
Accidental bushfire	Cigarette buff	128	79.5
	Others	33	20.5

Source: Author's Fieldwork, 2017.

7.3.1 Deforestation Resulting from Exploitation and Encroachment in Osun Osogbo Grove

Osun Osogbo sacred grove is at present experiencing degradation from the boundary and

this is alarming. However, through participant observation, it was discovered that there is increase pressure from population explosion and urban expansion and the deforestation of the grove, resulting from gracing and farming practices taking place along the boundary and buffer zone. In addition, the Museum management also confirmed an illegal hunting of wild animals around the buffer zone which they stressed is on the increase. They shared their experience that wild animals such as monkeys, snakes, and other reptiles, antelopes, forest antelopes, squirrels that were informed to be abundant in the grove decades ago are now scarce.

Table 8.7 Factors given by the Indigenes to be causing deforestation in Osun Sacred Grove include:

S/N	Reason for exploitation/encroaching the sacred grove	No of Respondents n= 161	Percent (%)
1.	Inadequate land for farming	40	25
2.	Neglect of cultural belief	140	87
3.	Government in total control	90	56
4.	Low employment of local people	50	31
5.	Current custodians' lack local knowledge of protection	45	28

Source Author's field work (2017)

Table 7.8: Factors given by the Government officials to be causing deforestation in Osun Sacred Grove

S/N	Reason for exploitation/encroaching the sacred grove	No of Respondents n = 4	Percent %
1.	Poachers engaged in illegal exploitation/hunting	4	100
2.	Indigenes turn the forest into farmland from the boundary	4	100
3.	Dislike for the strict nature reserve as measures for illegal exploitation	2	50

Source, Author's field work (2017)

However, respondents in the communities around the grove and the state officials differ in their positions on what factors contributes to deforestation in the grove (See Table 8.7 and 8.8) Some of the reasons given by the respondents to be causing deforestation in the grove include inadequate land for farming (25%), neglect of cultural belief (87%), government in total control of the grove area (56%), low employment of the local people in the grove (31%) and the fact that the Osun custodian and traditionalists lack adequate knowledge of protection (28%) has also been advanced .

About 56 percent voiced their discontent in the way government is in total control of the

grove and not involving the indigenes. Though the indigenes are divided over the possession of local knowledge to manage and protect the grove, it is just about 25 percent that believed that people in charge of the grove lack local knowledge of managing and protecting the grove. This indicates that many indigenes believe that the custodians and other traditionalists possess the local knowledge to manage and protect the grove. Moreover, the indigenes reported that local professionals are not fully incorporated in the conservation strategies of the grove and this has posed a great challenge to government and international conservation determinations. To effectively perform these duties, the local communities are of the opinion that some professional indigenes with adequate local knowledge should be employed and fully incorporated in the management strategies of the grove that has been in existence for centuries. Contrarily, the factors given by the state officials working in the grove to be causing deforestation though, minima include some of the indigenes turning the forest especially in the buffer zone to farmland (100%), poaching activities in illegal wood harvesting and hunting (100%) and their dislike for the strict nature reserve as measures against illegal exploitation in and around the sacred forest (50%) respectively (Table 7.8).

7.4. Poaching Activities in Osun Grove and OONP

Table 7.9: Poaching Activities in Osun Sacred Grove and OONP Buffer Zones

Variable	Respondents Osun Sacred Grove	Percentage	Respondent Oyo National Park	Percentage
Illegal Gracing	86	53.4	165	46.9
Illegal Hunting	67	41.7	55	15.8
Farming	2	1.2	82	23.4
Logging	6	3.7	44	12.7
Firewood	2	0.1	38	10.8
Harvesting	12	7.4	58	16.4
Mining	-	0	-	-
Other	-	0	4	1.2
Total	161	100	352	100

Source: Author's Fieldwork (2018)

Most residents in Osun Osogbo especially around the grove, whose knowledge of conservation practices are based on indigenous system believed that poaching and encroachment are minimized, especially when there is a clear-cut boundary demarcation making infringements

into the grove difficult. Most residents are farmers and only about 20% of them have farms around the grove, especially outside the buffer zone. The rest of them have their farms some distance away from the grove. Farming accounts for 2% of the type jobs of the residents. However, less than 5% have encroached illegally into the grove and altered the habitat which is very crucial to the ecological requirements of the Osun Osogbo. However, the situation in OONP is distinctive with more than 80 % around the Park engaged in farming with more than 45 % encroaching into the park. For instance, Wahab (2015) Akinyemi and Kayode (2010); Onyemkwe and Adesola (2014); Lameed (1995) discovered that alteration of habitat is a threat to survival of biodiversity in Old Oyo National Park, Oba, and Oluwa grove and Ghasaka-Gumti National Park respectively. Old Oyo National Park like other protected areas in Nigeria has suffered from many shapes of deterioration and incidents that threaten its safety. At the same time, it can represent major problems due to the increased number of people who engage in primary activities.

The scale and seriousness of threat in the five ranges revealed that logging was a high threat in Yemoso range while hunting was low. In Sepeteri range, honey tapping was high threat while hunting was low; Tede was the only range where no threat activity is high. They are all rated as low and medium. Marguba range has high level of grazing (46.9%) and honey tapping activities while logging and firewood harvesting were rated low, 12% and 10% respectively (Table 8.9). Also, in Oyo-ile range, grazing and hunting was high, while honey tapping is low. Hunting activities (23.4%) were recorded across the Park. These were frequently reported in dry season when the Park is easily accessible and visibility was very high. Grazing activity in the Park by the Fulani Bororo and Bokolo nomads is another major threat to the wooded savannah vegetation in the park. They also encroached into the Park during the dry season of the years.

This poaching activities in OONP were observed by Oyeleke *et al.* (2015); Oladeji *et al.* (2012); and Tijani;(2007) as well as the unwise use of natural resources have been the major threats facing the Park and have led to the extinction of some flora and fauna species

Many respondents supported the idea that Osun Osogbo sacred grove has widely been acknowledged as being of biodiversity and that explains the limited human interference and activities within the grove. Thus, the Osun Osogbo people complex socio-spiritual or sociocultural associations with deities and spirits of deities have contributed to the protection of forest ecosystems and biodiversity status in the site. In the overall, the research results showed that Osun Osogbo sacred grove, an indigenous conservation approach, supported more species turnover than the modern scientific state-managed Old Oyo National Park.

7.5 Ranking the Factors Affecting Forest Biodiversity Conservation in Osun Grove and OONP

The following factors were considered to be affecting the in-situ forest biodiversity conservation in the study area as positioned by the respondents that cut across the local people, stakeholders and government officials managing the protected areas (the OOG and the OONP). Fuelwood collections and gathering (19.60%), farming (21.50%) bush burning (17.83%), pastoralism (12.77%), deforestation (14.70 %) and national policy governing park (13.60%) respectively (See Table 7.10). These factors as identified by respondents are considered as threats to forest biodiversity conservation and preservation in the study sites. Though, most of these activities exist within and around the buffer zones of the protected areas. If these illegal activities are unchecked, it will pose a serious threat to conservation efforts in both the sacred grove and the national park.

Table 7.10 Factors affecting Forest Biodiversity Conservation in OOG and OONP and their Ranking

Factors / Variables	Contributory Percentages (%)	Cumulative Percentages	Ranking of each Factors
Fuelwood Collections	19.60	19.60	II
Farming	21.50	41.50	I
Bush burning	17.83	58.93	III
Pastoralism	12.77	71.7	VI
Deforestation	14.70	86.4	IV
Park Policy	13.60	100	V
Total	100		

Source: Authors Computations as summarized from the results.

From Table 7.10 the ranking revealed that farming has the highest ranking (I), followed by firewood collections and gathering (II), bush burning (III), deforestation (IV), pastoralism (V) and national park policy (VI). All the identified factors are considered in terms of their ranking as affecting the success of in-situ forest biodiversity conservation in the study area.

CHAPTER EIGHT

PERCEPTIONS OF THE PEOPLE ON THE RELATIVE EFFECTIVENESS OF INDIGENOUS AND MODERN TECHNIQUES OF *IN-SITU* BIODIVERSITY CONSERVATION

8.1 Effects of People's Perception on Forest Biodiversity Conservation in Osun Sacred Grove

Discussion with most of the respondents, the custodian of Osun sacred grove, the Yeye Osun and a few community leaders on their level of involvement in ecological environment management however revealed that indigenes of Osogbo community complement the efforts of the staff of National Museum and Monument and State officials in conserving biodiversity. This has, however, been the responsibility of the community for centuries, according to them. This, according to the traditionalists and community leaders, implies that they are fully involved in the preservation of ecological environments and cultural and religion activities usually performed in the grove. The data suggests that the residents have a good understanding of the importance of Osun grove as the home of spirits and deities and conservation of flora and fauna resources using their indigenous knowledge system.

Osogbo, where Osun sacred grove is located attaches great importance to the annual festival which brings people together. The grove and festival have been officially recognised since the National Commission for Museums and Monuments (NCMM) took over the responsibility of the conservation of the site. This has largely been done to preserve the exceptional fauna and flora of the grove, not leaving behind the cultural practices. It also transforms the economy of the community through tourism.

The Osogbo community of Osun State where Osun grove is located reported in the course

of FGD that, the sacred grove prevents wind havoc. The presence of the grove also brings rain but this is not spiritual to them. They believe in the role of trees in biodiversity conservation and evapotranspiration. However, community leaders emphasized and identified some of the objects of worship in the grove which vary from individual shrines, sacred spaces, Igbo Oya (Oya Bush), Igbo Oro (Oro Bush), Igbo Orubu (Orubu Bush), Igbo Ifa (Ifa Bush) Igbo Epa (Epa Bush) sacred grove to others. The Yeye Osun emphasized the significance of Osun River which drains the grove. Osun's image of water signifies a relation between nature, spirit and human beings as water in the Yoruba cosmology expresses divine action and symbolizes life (Plate 4.2). The mystical, natural and metaphorical significance in natural processes is attached to it. It is believed that the sacred water of Osun can make barren women pregnant, heal various diseases, ward off evil machination of the enemy and open the doors to prosperity and great success. Trees and statues are also considered as the objects of worship in the grove which has many bushes (Igbo Oro) with high spiritual values in the grove as highlighted above. In fact, they offer sacrifices to the deities in the grove. All these indigenous practices and approaches have been used to sustain the flora and fauna species for many centuries hence the high biodiversity status of the grove.



Plate 8.1 : The Researcher in an interview session with Yeye Osun –Custodian of Osun Grove.



Plate 8.2:The Custodian with the Researcher /Field Assistants



Plate 8.3: Interview Session with the Staff of the National Museum and Monument, Osun Grove



Plate8.4: Parts of Osun grove showing one of the Shrine Area

There is a consensus position on the effectiveness of indigenous knowledge system through the sacredness of the grove in maintaining and sustaining the forest species through the adoption

of sound taboos and sanctions in the community.

When we asked the Yeye Osun, the present custodian of the sacred grove, to comment on the present forest resources and wildlife in the grove, she indicated that she was satisfied with the way the sacred grove is been managed;

” I am happy with how the bush (Igbo Oroo) and the other important animal species are been preserved here, such as fish, wild animals, is prohibited for anyone to fish or cut any tree here without sacrifice to appease the Osun goddess and other deities. These practices have helped us to conserve this area for many centuries...”(Focus group discussion with Yeye Osun)The Yeye Osun comments suggest that traditional custodian are aware of the presence of flora and fauna resources and biodiversity which have been protected with their indigenous knowledge system for centuries. Such meetings with other community leaders help to determine a framework for local ownership of resources in the grove and for the role and responsibilities that indigenous people expect government agencies to play in resources management.



Plate 8.5 : FGD with some members of Osogbo group in Osun Grove

According to our participants, some of the reasons observed for recent difficulty in getting log woods and animal catching were anger of gods and environmental degradation. This could be attributed to the fact that, indigenous people see the grove as their heritage and protect it by not going against taboos. Local people, community leaders and custodians of Osun Osogbo grove share the responsibility of protecting the sacred forest. The positive role of sacred grove in the expression of indigenous knowledge of Osun people has been possible because of the collective efforts of these people to protect them. Sacred groves are good sources of a variety of medicinal plants, fruits, fodder, and fuelwood among others. It is believed that the grove which provides

habitat for the forest together is being considered as store house of biodiversity and provides important environmental functions to people. Naturally, the Osun grove provides local people with a variety of products as mentioned by our discussants.

The participants mentioned some of the benefits they derive from Osun grove. The communities of Osun sacred grove agreed that the grove serves as a source of food, income (especially during festive period) aesthetic, biodiversity and medicine. On comparative basis, each large settlement in the Southwestern region of Nigeria had sacred groves. Nearly all of these groves had been desecrated, destroyed or limited in size. Osun grove maintains the pride of being the only one consciously preserved and internationally recognized. The participants revealed that the Osun grove has a number of values attached to it. The grove is the symbol of the development of Osogbo society from its prehistoric beginning to the present.

The Osun grove shelters various land marks and features in the form of rocks, trees, plants, animals, soils, (significant ecosystems) shrines, temples, market, and others including the river itself. It was further revealed that these land marks are still active in the spiritual and physical well-being of Osogbo people. Tough customary taboos and sanctions still exist against fishing, hunting, felling, poaching and refuse dumping. This has help conserved a great variety of plant species especially medicinal herbs that now constitute the *in-situ* biodiversity and part of the heritage just as the Osun waters which are believed to be useful for healing and procreation (See Plate 8.6).



Plate 8.6: Osun River

8.2 Effects of People's Perception on Forest Biodiversity Conservation in OONP

The survey data of about 85 community leaders of residents perceptions together with information summarized from focus group discussions made it possible to analyze community perceptions on the effectiveness of modern knowledge systems. The results of the focus group discussion indicated that majority of the discussants had negative perceptions of *in-situ* biodiversity conservation efforts in the Park.

Discussion with the community leaders and local dwellers about their perception on the effectiveness of modern methods of biodiversity conservation however revealed that the indigenes of the areas do not see any reason why they should be denied access to the resources in

their areas. Though, they have understanding of the importance of National Park but with limitations. The FGD with Chief of Ibo-Ologun and Obalufin of Sepeteri emphasized that'' ***My people are predominantly farmers they would have love to use their land for farming activities but since it was demarcated as a National Park they cannot do otherwise than to support government efforts. Many of them now claimed they engaged in hunting expedition because of the park***'' Discussion with most of the residents in Tede and Magoubu on their level of involvement revealed that the residents appreciate the existence of the Park conservation and that they were occasionally contacted in recruitment of junior staff, but are not involved in any other matter pertaining park management. However, there exists a buffer zone from the park boundary, which is at least 4 kilometers away. In order to ensure the proper protection of biodiversity, community members are free to practice their socioeconomic activities within 0-5 kilometers from the Park boundary. Such areas are regarded as buffer zones in Park management. The areas are designed to offer appreciable economic benefits to indigenes in order to solicit their participation in biodiversity both flora and fauna conservation programmes.

The participants agreed that aside from Tessi Koro and Soro, other communities from the remaining study locations at Sepeteri, Tede, Gboduro, Igbo- Ologun, Abuja and Dongari Iju believe that their socioeconomic activities such as farming, hunting, animal gracing, lumbering, logging, gathering etc. have no bearing on forest biodiversity conservation. However, given that forest stocks are lower in the buffer zones than in protected areas, the capacity of the local people to carry out their socioeconomic activities for community development without degrading the reserve base is limited. However, the effectiveness of anti-poaching strategies and activities in Osun sacred grove and Old Oyo National Park, is to some extent, progressive and consistent as many encroachment attempts were in the buffer zones which tend to support and encourage in

in-situ forest biodiversity conservation and nature reserves in the sites as submitted by the discussants.

All these have revealed that OONP management does not adequately involve local communities in its operations. Though in the opinion of the Oba of Sepeteri:

“I am happy with how trees and animals are being protected by rangers and their management.....I am also glad that when rangers arrest poachers, they bring them to me so I can see these people though the rangers don’t usually release the log woods, charcoals and confiscated carcasses to me” (focus group discussion with Oba of Sepeteri).

According to the Community head in Tede, one of the buffer village, he said:

“We were promised jobs for our children, social amenities for our community, see the abandoned water project, not working, there are other things we were promised yet we are not to move close to the Park though we are told other communities have benefitted” (A Community leader in Tede”. It is quite clear that the communities which put up with inconvenience of forest resources and wildlife should be the principal beneficiaries of any exploitation in order to ensure full support through programme contribution to community welfare. And involvement in Park decision making.

Among the discussants are farmers, hunters, loggers and charcoal/firewood sellers who were unhappy with the restrictions policy on exploiting the resources in the park. Some of their responses are listed below:

“ My only means of livelihood is hunting which I have inherited from my father. Presently, I am of age and I have no other means of livelihood”

“This restriction is really affecting me and my family, There is a tree species called igi-ara

with its high value in the market and its abundance in the park but with this restrictions no way for us''

'' Many of us here, have not seen the benefit the OONP has brought for us.I hope the government should employ more of our people that are jobless How do you want me to support what is not of benefit to us''

'' I don't know if conservation objectives can be achieved here, unless basic needs of the local people here are met''(See Plate 8.7).

'' I think the only solution to support conservation efforts is for government to establish tertiary institutions and provide infrastructure in our area (Sepeteri).This I believe will engender a decrease in the pressure some of us put on the park through wood harvesting, charcoal production and hunting.

The findings from the various sessions of discussions showed that most discussants are jobless graduates within their households, most of whom expected to be working for government in the park. This followed the reports of Tijani (2007);Toyobo *et al*,(2014) andWahab, (2016)..The results here showed that the biodiversity conservation efforts in OONP has not wholly succeeded despite several incentives introduced by park management including community-based support zone incentives.



Plate 8.7: Some FGD Participants in Sepeteri Village one of the ranges in OONP.

When we inquired from the elders of Sepeteri, Tede, and Oyo-Ile and our other respondents, their comments suggest that the indigenes are aware of the difficulties encountered in managing wildlife and protected areas. Such meeting with leaders according to Buolya (2004) and Tijani (2007) help determine a framework for local ownership of resources and for the role and responsibilities that local people expect government agencies to play in resource management.

In terms of effectiveness of the Park management of forest resources, majority of the

respondents claimed that the management have to some extent been effective in protecting the resources



Plate 8.8 Some of the FGD Participants in Ago OONP Community.

but have failed to benefit the local people as much as expected. All these have revealed that OONP management does not adequately involve local communities in its operations. Though in the opinion of the Oba of Sepeteri:

According to the Community head in Tede, one of the buffer village, he said:

“We were promised jobs for our children, social amenities for our community, see the abandoned water project, not working, there are other things we were promised yet we are not to move close to the Park though we are told other communities have benefitted” (A Community

leader in Tede).



Plate 8.9: Group Photographs at the end of a Session of a FGD in OONP



Plate 8.10: FGD Session in Igbo Ologun a Buffer Community in OONP

CHAPTER NINE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

9.0 Introduction

This study was focused on a comparative analysis of indigenous and modern knowledge systems of *in-situ* forest biodiversity conservation in Southwestern Nigeria. In Osun Osogbo Saced grove, the indigenous knowledge of forest biodiversity conservation technique was adopted and applied. This technique involves the protection and preservation of Osun grove still recognized as one of the very few primary forest around in Southwestern Nigeria. The indigenous practices include the use of sanctions, taboos, myths and cultural beliefs. In the case of Old Oyo National Park, the operation and techniques is modern and scientifically based, with Park Guards on ground to monitor any forms of encroachment or poaching in the Park. The vegetation is secondary in nature with a wide variety of species.

The Park has put in strategies to provide incentives and livelihood opportunities to provide means of alternatives to the people and communities in the five ranges to lessening encroachment and poaching activities. The two approaches have, to some extent, been successful. The OONP has adopted two main approaches in its conservation effort, the preservation and the community-based conservation approach which has been adopted as participatory to address the problems associated with excluding human activities in the Park. The other approach is the community-based conservation approach which involves initiatives aimed at conserving biodiversity in the park but also letting the local communities benefit from the Park. The later approach creates incentives to the local communities to improve their livelihoods and provision of social amenities to ameliorate their living conditions.

9.1 Summary of Findings

The study assesses comparatively, the indigenous and modern techniques of *in-situ* forest biodiversity in Osun Osogbo and Old Oyo National Park. The two knowledge systems have been designed to preserve and protect the forest biodiversity through different approaches and techniques to achieve biodiversity conservation and totally eliminate pressure on grove and Park resources. The main findings of this study are summarized as follows:

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- a. The residents have classified the management of sacred grove in Osun Osogbo as being indigenous knowledge-based using techniques such as taboos, and sanctions to bring about protection of forest resources and biodiversity. On the other hand, on the basis of the scientific knowledge systems in managing Old Oyo National Park, the residents believed it is modern with a clear defined methods of operation in preserving and protecting the biodiversity in the area.. The findings further showed that about 96.1%, 97.5% and 90.9% of respondents, stakeholders and staff respectively wanted indigenous management systems in Osun grove, while, 90.1%, 92.6% and 87.8 % of the respondents, stakeholders and staff wanted modern approach to forest management;
- b. The biodiversity status of the study area was evaluated in order to determine the conservation priority setting of the two sites. The findings indicate varied values of biodiversity

components in terms of species diversity, abundance and evenness in the study sites which revealed a much higher diversity in Osun Osogbo grove as an undisturbed primary forest habitat 'Igbo-oro' than the site from the secondary forest in Old Oyo National Park [OONP]. 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 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;

c. There exists a clear relationship between the indigenous conservation technique and modern conservation practice. The results of ANOVA showed that a significant difference exist between indigenous and modern forest conservation methods in the study area; The two knowledge system application s 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 our 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 grove.

d. Both indigenous and modern techniques of forest conservation encouraged the diversity of species .Species Diversity Index ranges from 3.01- 3.48.

e. The challenges of biodiversity in the two sites include fuel wood collection, deforestation, farming, bush burning, pastoralism, Osun Osogbo festival and poaching.

f. The result of the Focus Group Discussion showed that majority of the discussants viewed indigenous knowledge system as an effective method of conservation and that the non

implementation of government incentives programme promised to the local communities is a bane to effective forest biodiversity conservation.

The thrust of management, utilization, and conservation of natural resource rests with the traditional institutions in Osun Osogbo grove. To some extent, the Museum and Monument Commission, though their role is supervisory in nature, but it does not have requisite knowledge and experience to manage Osun Osogbo sacred grove while that of the OONP depends on conventional and scientific methods. It was also realized that modern conservation method cannot adequately preserve the forest biodiversity. For this reason, there is the need to integrate the indigenous technique through the establishment of sacred forests to protect and restore these ecosystems through sanctions, taboos, myths and other supernatural means to reduce poaching and ultimately lessen biodiversity loss.

9.2 Conclusion

The rationale for sacred grove biodiversity conservation is quite different from the rationale for setting aside modern and scientific-managed national park. Furthermore, the enforcement and sanctioning mechanisms are also differed. Modern knowledge system based protection techniques depends on legal frameworks and numerous park officers to enforce the laws while the indigenous based system of *in-situ* biological diversity conservation is mostly enforced by community members. Though, efforts to incorporate natural sacred sites in conservation initiatives is not entirely new, there is need to emphasize an alternative view of *in-situ* forest biodiversity conservation practices that is led by modern and scientific approach alone. This study discovered that the integration of Osun Osogbo sacred grove into the existing Old Oyo National park network should take into account the rich biodiversity and local ecology of the area and the prevailing threats .Consequently, it could be unwise to rely on a single

conservation approach.

The study has shown that indigenous knowledge can play a complementary role in biodiversity conservation. Local water, soil and ecosystems management restrictions and prohibition on fishing, hunting, clear-cutting of trees and the ecological value of sacred forests provide keys to involve indigenous knowledge and practice in a explicit way than before in *in-situ* forest biodiversity conservation development and management. This study therefore concluded that indigenous conservation techniques yielded better conservation results than modern techniques.

9.3 Recommendations

This study has provided more insight into the variation and relationships between applications of indigenous knowledge techniques of sacred grove and modern knowledge system of scientific management of *in-situ* forest biodiversity conservation in Southwestern Nigeria. There is need for government to set up policies and strategies to protect the indigenous people's cultural heritage such as the sacred forest so that they would not be tampered with during developmental projects resulting from urbanization process and other land use competing activities. Individuals must appreciate the benefits gained from sacred forests beyond religious activities, but also as it concerns the conservation of biological diversities.

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 afforestation programmes to attract wildlife and animal species to boost tourism. This can be properly harnessed by the local communities and government. 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 (e.g. crop residue, organic refuse) in order to reduce pressure on fuelwood from the *in-situ* conservation.

d. Figure 10.1 illustrates the factors contributing to preservation/conservation and socio-economic importance of forest biodiversity conservation in Osun Osogbo and Old Oyo National Park.

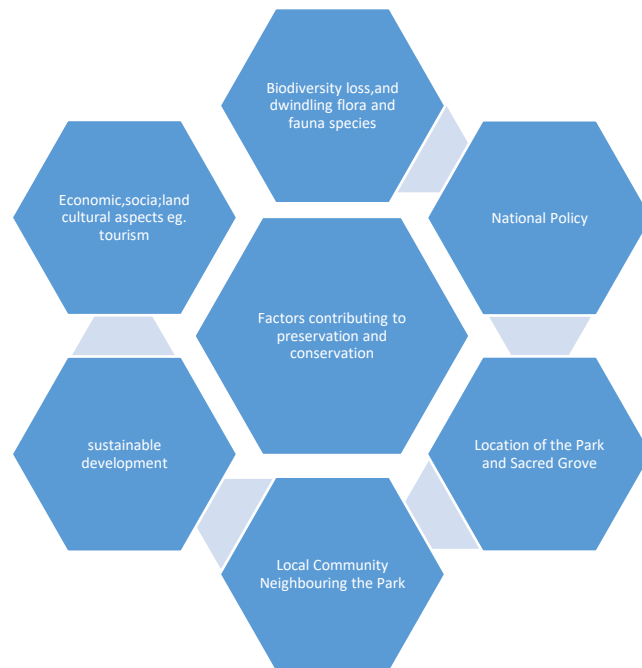


Figure 9.1 Factors influencing Conservation in the Study Area

As this study has shown, factors that affect biodiversity conservation were not uniform across the two study sites in terms of their varying knowledge-based applications. In each case, there were specific underlying causes that influenced each of the identified factors. Therefore, it is imperative to revise Nigeria's forest policies to address the overall suboptimal state of the *in-situ* forest biodiversity.

e. The application of indigenous knowledge system in *in-situ* forest conservation has a long history and is presently gaining acceptance in the protection of remaining biodiversity for sustaining socio-economic development. This study reveals that indigenous knowledge, which includes the cultural beliefs of the people in the sacred forest, is helping to protect the community forest. The major benefits of the sacred forest to the people are issues related to religious activities but should rather also be concerned with the conservation of biological diversities. There is urgent need to develop national policies to support the Indigenous

Knowledge which could result in new partnerships between local communities, government, civil societies and academia.

The study also revealed that biodiversity in OONP depends on the relations between local people and staff and, to a large extent, the success of conservation of modern knowledge-based scientific management of plant and animal species and their habitats. Hence, local people should contribute and involved in solutions to ban enroachment and poaching in the conservation areas and be given more locally owned social acceptance and incentives. Local communities should be involved in monitoring and maintenance of the sacred grove and the park in order to ensure sustainable forest management.

Thus, this study recommended that indigenous conservation techniques should be given priority over modern techniques and where necessary both should be integrated.

Finally, there is need for sufficient integration of biodiversity issues into conservation policies, strategies and programmes in order to address significant underlying drivers of biodiversity loss in Southwestern Nigeria.

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APPENDICES

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL MANAGEMENT

UNIVERSITY OF ILORIN, ILORIN.

Dear Respondents,

This questionnaire is meant to seek information on the technique of biodiversity conservation on Osun grove, Osun State and Old Oyo National Park, Oyo State. The aim is to gain an understanding of the indigenous conservation methods and the modern conservation methods and their effectiveness in achieving biodiversity sustainability. All information supplied therefore will be treated with utmost confidentiality. Thank you for your cooperation.

Yours faithfully,

Ajadi, B.S

07031182966

Instruction

: Please tick your correct options inside the boxes/spaces provided

Section A: Socio-Demographic Information of Respondents

1. Name of Community.	
2. Local Government Area.	
3. Ethnic Group	
4. Sex	

Years of Residency	
5. What is your household size?	
(a) 1-5 people (b) 6-11 people (c) 12 & above	

Section B: Socio-Economic Characteristics of the Respondents Demographic

(6) Age of Respondents

i.	15-24	
ii.	25-34	
iii.	35-44	
iv.	45-54	
v.	55-64	
Vi.	65 rs& above	

7. Religion

i.	Christianity	
ii.	Islamic	
iii.	African Traditionist	

8. Marital status

i.	Single	
----	--------	--

ii.	Married	
Iii	Divorced/Separated	
iv.	Widow	

9. Educational Status

i.	Tertiary	
ii.	Secondary	
Iii	Primary	
iv.	No Formal Education	

10. Occupation

i.	Civil Servant	
ii.	Herbalist	
iii.	Teaching	
iv.	Hunting	
v.	Fishing	
vi.	Farming,state the size in acre	
vii.	Fuelwood harvesting	
viii.	Grazing/Livestock	

ix.	Others (Specify)	
-----	------------------	--

11.Respondents Income Group per annum (In naira)

i.	>200,000	
Ii	250,000- 500,000	
iii.	>above 1,000,000	

12.No of working People in an Household

I	>3	
Ii	3-6	
Iii	>6	

Section C: Information on the role of indigenous and modern knowledge systems on biodiversity conservation

13.Reasons reason for sacred grove/national park preservation

I	Tourism	
Ii	Home of deity/place of worship	
iii.	Historical/cultural importance	
iv.	Nature preservation	
v.	Education and research	

14.Traditional belief that contributed to sacred grove preservation

I	Place of important community festival	
Ii	Fear of deity	
iii.	Place of worship,healing & miraculous site	
iv.	No idea	

15.Factors given by the indigenes to be preventing tree felling and collection in sacred grove

i.	Abomination	
ii.	Offer sacrifice before felling tree	
iii.	Taboos/superstition	
iv.	Nature preservation	
v.	No response	

16.Factors given by the indigenes to be causing deforestation in Osun Sacred Grove& OONP

I	Neglect of the local belief	
Ii	Lack of local knowledge of protection by the present custodian	
iii.	Low employment of local people	

iv.	Government is in total control	
v.	Indigene land for farming	

17.Factors given by the government officials to be causing deforestation in Osun Sacred Grove /OONP

i.	Poachers carryout illegal hunting of the wild animals	
Ii	Local communities turn the forest into farmland from the boundary	
iii.	.Hatred for the strict nature r eserve as preventive measures to illegal	

18. What is your understanding of the existence of Osun Grove and Old Oyo National Park in the conservation of biodiversity?

(a) home of deity-Osun goddess (b) preserve for worship purpose (c) protection from from exploitation (d) abomination and superstition (e) social-cultural and spiritual and economic benefits derived by the people

19. In what ways does traditional belief or modern system affect biodiversity conservation?

1 2 3 4 5 6 7

(a) Introduction of taboo days							
(b) establishment of sacred groups/shrine							
(c) introduction of legislation /laws							
(d) establishment of national parks							
(e)abomination /superstition							

(f) effectiveness of traditional institutions							
(g)effect of western conservation system							

Section E: Information on Respondents' perceived relevance of indigenous and modern methods on biodiversity conservation.

20. Relevance of indigenous methods on biodiversity conservation

i.	Ethical values	
ii.	Spiritual values	
iii.	Cultural values	
Iv	Royal traditions	
v.	Taboos and myths	
vi.	Livelihood traditions	

21.Relevance of Modern methods on biodiversity conservation

i.	Tourism	
ii.	Education and research	
iii.	Cultural values	
iv.	Government policies	
v.	Aesthetic values	

22. Respondents preference values attached to plant species utilisation

i.	Timber	
----	--------	--

ii.	Food	
iii.	Medicine	
iv.	Building	
v.	Gracing	
vi.	Fibre	
vii.	Fuel wood	
viii.	Cultural values	
ix.	Aesthetics	
X	Employment	

24.Respondents' perceived importance of components of indigenous knowledge

Components of IKS	Strongly	Agree	Partially	Do not
	Agree		agree	Agree
i. Botanical Knowledge is important				
ii. Ecological Knowledge is important				
iii. Technical Knowledge is important				
iv. Institutional Knowledge is important				
v. Behavioural Knowledge is important				
vi. Economic Knowledge is important				
vii. Legal Knowledge is important				

25.Respondents' rating of status and constraints to the use of Indigenous Knowledge

ITEM STATEMENT	Strongly Agree	Agree	Partially Agree	Do not Agree
i. Indigenous conservation practices are declining				
ii. Declining indigenous conservation practices is detrimental to forest resources				
iii. Indigenous knowledge needs to be documented Traditional knowledge should be made public				
iv. Traditional conservation practices should be revived and enforced.				

26. Which of the following Human Activities Affect the Success of Biodiversity Conservation in Osun Grove? Please accord them ratings (1-5)

Fuel wood/dead wood Collection

Farming

Bush Burning

Osun Festival

Deforestation

Indepth Interview/ Focus Group Discussion

Location	Time	Investigator
-----------------	-------------	---------------------

Introduce myself and purpose of study

Please Introduce yourself [one by one]

Tell me a brief history of the village

Probe: Which of the villages is more populous, than which? And so on, what are the major occupations in this village? Do your women do the same occupation?

Probe: Have you ever visited the Osun Grove/ Old Oyo National Park before?

Probe: If no why?.....

If yes for what reason.....

Probe: What would you say about the number of various animals and trees found around the grove/Park? (a) Increasing (b) Decreasing (c) Stable

Probe: What is your opinion with respect to reasons to conserve Osun Grove/ OONP as protected areas?

Probe: What is your opinion with respect to reasons to conserve Osun Grove/OONP as

indigenous and formal protected areas?

Reason	Percentage in agreement
Reserve for plants and wild animals	
Important source of timber and meat	
Conservation for future generations	

Probe: Does the Grove /Park Management usually consult your community on any decision affecting Grove/Park management?

Probe: What is your view/comment on the present local forest/wildlife management in Osun Grove/OONP?

Section Two

Probe: Does the establishment of the Osun Grove local forest reserve/ National Park project bring any benefit to your household? If yes list such benefits in order of importance

- i).
- ii).
- iii).
- iv)

Probe:. Based on your knowledge of the environment and observations, what are the various threats to the existence of the grove/Park

Probe: With the fast changing cultures do you think the belief systems such as taboos and sanctions in in-situ biodiversity conservation can have negative implications?

Probe: Does your community suffer any loss as a result of the Sacred Grove /Park in your areas? If yes, how?

- a) I cannot farm in the sacred grove/Park

b) I cannot hunt in the sacred grove/Park

c) The animals destroy my crops

d) The worshipers/ visitors disturb me

e) Others

(specify).....

Probe: Do you agree that the sacred grove/Parks are the best sources of a variety of medicinal plants, fruits, fodder, fuelwood among others? Can you mention some of their benefits from the grove /Park?

Probe: In your own opinion what are the species of plants or animals that are useful for specific purposes? Are you allowed to collect these plant/animal varieties in the grove/Park?

Probe: Have you ever noticed /observed any form of encroachment to the core zone of the sacred grove?

Probe: Which of the following socioeconomic and cultural benefits are derived by your community from sacred grove /Park?

a) Employment

b) Social amenity

c) Promotion of art and culture

d) Protection

e) Healing (solution to barrenness)

f) Revenue generation

g) Tourism

Probe: Is indigenous knowledge system especially in the areas of abomination, offer of sacrifice before falling trees, taboos/superstition, nature preservation effective in preventing tree felling

and hunting in the sacred grove? What is your opinion in this area?

Probe: How would your community prioritize their needs as relates to the utilization of the financial support from government if there is any?

- a) Construction of fences around the sacred site/Park
- b) Rehabilitation of the degraded landscape with fodder trees
- c) Management, as relates to livestock grazing within the sacred forest/Park
- d) Cultivation of medicinal and aromatic plants
- e) Exploration of the tourism potential
- f) Construction of water tanks to store water for irrigation purposes and personal uses.

Probe: Which policies do you put in place to discourage encroachment and poaching in the sacred grove/Park? Does the indigenous knowledge play significant role in biodiversity conservation as the formal approach? Do you agree there is need for integration of both systems for effective biodiversity conservation and sustainable development?

APPENDIX 2

Summary of Canonical Discriminant Functions

Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	.044 ^a	100.0	100.0	.205

a. First 1 canonical discriminant functions were used in the analysis.

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	Df	Sig.
1	.958	6.640	9	.675

Standardized Canonical

Discriminant Function

Coefficients

	Function
	1
Age	-.206
Sex	.098
Leveled	.348
Hhincome	-.317
Hhlabor	.372
Religion	-.651
Marital	.566
Hhfarm	-.130
Govteffect	-.072

Structure Matrix

	Function
	1
Religion	-.579
Marital	.542
Hhincome	-.298
Hhlabor	.267
Age	-.226
Leveled	.211

Hhfarm	-.045
Sex	-.044
Govteffect	-.010

Pooled within-groups

correlations between

discriminating variables

and standardized canonical

discriminant functions

Variables ordered by

absolute size of correlation

within function.

Functions at Group

Centroids

	Function
Y	1
.00	.190
1.00	-.229

Functions at Group

Centroids

Y	Function
	1
.00	.190
1.00	-.229

Unstandardized

canonical discriminant

functions evaluated at

group means

Classification Statistics

Classification Processing Summary

Processed		161
Excluded	Missing or out-of-range group codes	0
	At least one missing discriminating variable	0
Used in Output		161

Prior Probabilities for Groups

Y	Prior	Cases Used in Analysis
---	-------	------------------------

		Unweighted	Weighted
.00	.500	88	88.000
1.00	.500	73	73.000
Total	1.000	161	161.000

Classification Results^a

			Predicted Group Membership		Total
			.00	1.00	
Original	Count	.00	53	35	88
		1.00	33	40	73
	%	.00	60.2	39.8	100.0
		1.00	45.2	54.8	100.0

a. 57.8% of original grouped cases correctly classified.

Discriminant

Analysis Case Processing Summary

Unweighted Cases		N	Percent
Valid		345	100.0
Excluded	Missing or out-of-range group codes	0	.0

At least one missing discriminating variable	0	.0
Both missing or out-of- range group codes and at least one missing discriminating variable	0	.0
Total	0	.0
Total	345	100.0

Group Statistics

Y		Mean	Std. Deviation	Valid N (listwise)	
				Unweighted	Weighted
.00	Age	30.0774	9.34181	168	168.000
	Sex	1.4583	.49975	168	168.000
	Leveled	2.5714	1.80343	168	168.000
	Incomehh	371835.5000	65675.86675	168	168.000
	Labourhh	8.0655	2.82449	168	168.000
	Religion	2.0595	.83129	168	168.000
	Marital	2.5774	1.12403	168	168.000
	Farmhh	8.5000	4.36508	168	168.000
	Govtfect	1.6250	1.17197	168	168.000
1.00	Age	29.8870	9.16631	177	177.000
	Sex	1.5593	.49788	177	177.000
	Leveled	2.5763	1.72749	177	177.000
	Incomehh	375566.1638	73300.29322	177	177.000
	Labourhh	7.4576	2.90174	177	177.000
	Religion	1.9322	.80899	177	177.000
	Marital	2.4746	1.07168	177	177.000
	Farmhh	8.4237	3.97522	177	177.000

	Govtefect	1.5028	1.11867	177	177.000
Total	Age	29.9797	9.23921	345	345.000
	Sex	1.5101	.50062	345	345.000
	Leveled	2.5739	1.76230	345	345.000
	Incomehh	373749.4928	69616.05993	345	345.000
	Labourhh	7.7536	2.87636	345	345.000
	Religion	1.9942	.82121	345	345.000
	Marital	2.5246	1.09709	345	345.000
	Farmhh	8.4609	4.16370	345	345.000
	Govtefect	1.5623	1.14490	345	345.000

Summary of Canonical Discriminant Functions

Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	.036 ^a	100.0	100.0	.187

a. First 1 canonical discriminant functions were used in the analysis.

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	Df	Sig.
1	.965	12.078	9	.209

Standardized Canonical

Discriminant Function

Coefficients

	Function
	1
Age	.041
Sex	-.533
Leveled	.040
Incomehh	-.148
Labourhh	.639
Religion	.493
Marital	.249
Farmhh	.077

Standardized Canonical

Discriminant Function

Coefficients

	Function
	1
Age	.041
Sex	-.533
Leveled	.040
Incomehh	-.148
Labourhh	.639
Religion	.493
Marital	.249
Farmhh	.077
Govtefect	.252

Structure Matrix

	Function
	1
Labourhh	.558
Sex	-.533
Religion	.408
Govtefect	.281
Marital	.246
Incomehh	-.141
Age	.054
Farmhh	.048
Leveled	-.007

Pooled within-groups

correlations between

discriminating variables

and standardized canonical

discriminant functions

Variables ordered by

absolute size of correlation

within function.

Functions at Group

Centroids

Y	Function
	1
.00	.195
1.00	-.185

Unstandardized

canonical discriminant

functions evaluated at

group means

Classification Statistics

Classification Processing Summary

Processed		345
Excluded	Missing or out-of-range group codes	0
	At least one missing discriminating variable	0
Used in Output		345

Prior Probabilities for Groups

Y	Prior	Cases Used in Analysis	
		Unweighted	Weighted
.00	.500	168	168.000
1.00	.500	177	177.000
Total	1.000	345	345.000

Classification Function

Coefficients

	Y	
	.00	1.00
Age	.346	.345
Sex	5.140	5.547
Leveled	.952	.943
Incomehh	7.700E-5	7.780E-5
Labourhh	1.081	.996
Religion	3.494	3.265
Marital	2.441	2.355
Farmhh	.365	.358

Govtefect	.953	.870
(Constant)	-38.619	-37.939

Fisher's linear discriminant functions

Classification Results^{b,c}

			Predicted Group Membership		Total
			.00	1.00	
Original	Count	.00	96	72	168
		1.00	71	106	177
	%	.00	57.1	42.9	100.0
		1.00	40.1	59.9	100.0
Cross-validated ^a	Count	.00	93	75	168
		1.00	81	96	177
	%	.00	55.4	44.6	100.0
		1.00	45.8	54.2	100.0

a. Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.

b. 58.6% of original grouped cases correctly classified.

c. 54.8% of cross-validated grouped cases correctly classified.

ANOVA

Variation across the groups (Group 1 to 15)

Variables		Sum of Squares	df	Mean Square	F	p-value.
DBH(cm)	Between Groups	708190.619	14	50585.044	12.152	0.000 (Sig.)
	Within Groups	2214602.898	532	4162.787		
	Total	2922793.517	546			
H(m)	Between Groups	5716.609	14	408.329	5.339	0.000 (Sig.)
	Within Groups	40612.746	532	76.484		
	Total	46329.355	546			

Variation across Yemeso

		Sum of Squares	Df	Mean Square	F	p-value
DBH(cm)	Between Groups	26843.276	18	1491.293	1.243	0.302 (Not Sig.)
	Within Groups	29989.633	25	1199.585		
	Total	56832.909	43			
H(m)	Between Groups	249.117	18	13.840	1.804	0.085 (Not Sig.)
	Within Groups	191.792	25	7.672		
	Total	440.909	43			

Variation across Alaraba Saki West

		Sum of Squares	Df	Mean Square	F	p-value
DBH(cm)	Between Groups	33398.728	21	1590.416	3.172	0.004 (Sig.)
	Within Groups	11531.583	23	501.373		
	Total	44930.311	44			
H(m)	Between Groups	274.769	21	13.084	2.781	0.010 (Sig.)
	Within Groups	108.208	23	4.705		
	Total	382.978	44			

Variation across Magoro

		Sum of Squares	Df	Mean Square	F	p-value
DBH(cm)	Between Groups	51130.111	20	2556.506	8.529	0.000 (Sig.)
	Within Groups	8092.889	27	299.737		
	Total	59223.000	47			
H(m)	Between Groups	283.922	19	14.943	1.941	0.056 (Not Sig.)
	Within Groups	207.822	27	7.697		
	Total	491.745	46			

Variation across Oyo Ile

		Sum of Squares	Df	Mean Square	F	p-value
DBH(cm)	Between Groups	229336.203	37	6198.276	0.331	0.100 (Not Sig.)
	Within Groups	748346.015	40	18708.650		
	Total	977682.218	77			
H(m)	Between Groups	877.270	37	23.710	2.689	0.001 (Sig.)
	Within Groups	352.679	40	8.817		
	Total	1229.949	77			

Variation across Oyo Ile II

		Sum of Squares	Df	Mean Square	F	p-value
DBH(cm)	Between Groups	42452.159	23	1845.746	8.516	0.000 (Sig.)
	Within Groups	6285.765	29	216.751		
	Total	48737.925	52			
H(m)	Between Groups	350.890	23	15.256	6.843	0.000 (Sig.)
	Within Groups	64.657	29	2.230		
	Total	415.547	52			

Variation across Tede

		Sum of Squares	Df	Mean Square	F	p-value
DBH(cm)	Between Groups	179742.290	14	12838.735	7.403	0.004 (Sig.)
	Within Groups	13874.667	8	1734.333		
	Total	193616.957	22			
H(m)	Between Groups	870.978	14	62.213	5.499	0.010 (Sig.)
	Within Groups	90.500	8	11.313		
	Total	961.478	22			

Variation across Kaaka

		Sum of Squares	Df	Mean Square	F	p-value
DBH(cm)	Between Groups	18214.952	8	2276.869	0.690	0.694 (Not Sig.)
	Within Groups	39572.857	12	3297.738		
	Total	57787.810	20			
H(m)	Between Groups	2223.071	8	277.884	19.251	0.000 (Sig.)
	Within Groups	173.214	12	14.435		
	Total	2396.286	20			

Variation across Erin

		Sum of Squares	Df	Mean Square	F	p-value
DBH(cm)	Between Groups	85459.259	18	4747.737	8.167	0.000 (Sig.)
	Within Groups	14533.900	25	581.356		
	Total	99993.159	43			
H(m)	Between Groups	1752.327	18	97.352	1.342	0.244 (Not Sig.)
	Within Groups	1813.400	25	72.536		
	Total	3565.727	43			

Variation across the ranges

		Sum of Squares	Df	Mean Square	F	p-value
DBH(cm)	Between Groups	236192.542	22	10736.025	6.829	0.000 (Sig.)
	Within Groups	33016.094	21	1572.195		
	Total	269208.636	43			
H(m)	Between Groups	709.727	22	32.260	4.035	0.001 (Sig.)
	Within Groups	167.909	21	7.996		
	Total	877.636	43			

Variation across Marguba

		Sum of Squares	Df	Mean Square	F	p-value
DBH(cm)	Between Groups	33859.184	17	1991.717	81.295	0.087 (Not Sig.)
	Within Groups	24.500	1	24.500		
	Total	33883.684	18			
H(m)	Between Groups	184.421	17	10.848	0.001	0.340 (Not Sig.)
	Within Groups	0.110	1	0.100		
	Total	184.421	18			

Variation across Table 11

		Sum of Squares	Df	Mean Square	F	p-value
DBH(cm)	Between Groups	11014.929	11	1001.357	13.860	0.069 (Not Sig.)
	Within Groups	144.500	2	72.250		
	Total	11159.429	13			
H(m)	Between Groups	61.500	11	5.591	0.021	0.234 (Not Sig.)
	Within Groups	0.002	2	0.011		
	Total	61.500	13			

Variation across Sepeteri

		Sum of Squares	Df	Mean Square	F	p-value
DBH(cm)	Between Groups	25134.351	11	2284.941	2.027	0.179 (Not Sig.)
	Within Groups	7891.333	7	1127.333		
	Total	33025.684	18			
H(m)	Between Groups	141.965	11	12.906	1.594	0.275 (Not Sig.)
	Within Groups	56.667	7	8.095		
	Total	198.632	18			

Variation across Table 13

		Sum of Squares	df	Mean Square	F	p-value
DBH(cm)	Between Groups	4941.057	8	617.632	0.901	0.575 (Not Sig.)
	Within Groups	3427.300	5	685.460		
	Total	8368.357	13			
H(m)	Between Groups	81.629	8	10.204	0.832	0.612 (Not Sig.)
	Within Groups	61.300	5	12.260		
	Total	142.929	13			

Variation across N08⁰ 45 087

		Sum of Squares	df	Mean Square	F	p-value
DBH(cm)	Between Groups	40111.341	15	2674.089	4.816	0.031 (Sig.)
	Within Groups	3331.750	6	555.292		
	Total	43443.091	21			
H(m)	Between Groups	25110.773	15	1674.052	0.012	0.561 (Not Sig.)
	Within Groups	0.024	6	0.011		
	Total	25110.773	21			

Variation across Grove Osogbo

		Sum of Squares	df	Mean Square	F	p-value
DBH(cm)	Between Groups	200877.395	31	6479.916	2.307	0.015 (Sig.)
	Within Groups	75832.333	27	2808.605		
	Total	276709.729	58			
H(m)	Between	2498.404	31	80.594	1.316	0.236(Not

	Groups					Sig.)
	Within Groups	1653.833	27	61.253		
	Total	4152.237	58			

Variation across the Study Sites

		Sum of Squares	df	Mean Square	F	p-value
DBH(cm)	Between Groups	40111.341	15	1674.089	2.554	0.038 (Sig.)
	Within Groups	3331.750	6	255.292		
	Total	43443.091	21			
H(m)	Between Groups	25110.773	15	1674.052	0.03	0.913 (Not Sig.)
	Within Groups	0.024	6	0.011		
	Total	25110.773	21			

Variation across Grove Osogbo

		Sum of Squares	df	Mean Square	F	p-value
DBH(cm)	Between Groups	200877.395	31	6479.916	2.307	0.015 (Sig.)
	Within Groups	75832.333	27	2808.605		
	Total	276709.729	58			
H(m)	Between Groups	2498.404	31	80.594	1.316	0.236(Not Sig.)
	Within Groups	1653.833	27	61.253		
	Total	4152.237	58			

Independent Samples Test

Group Statistics

Variables	Range and Grove	N	Mean	Std. Dev.
DBH(cm)	Range	488	80.63	71.435
	Grove	59	135.93	69.071
H(m)	Range	488	9.49	9.217
	Grove	59	13.59	8.461

Independent Samples Test

Variables	T	df	p-value
DBH(cm)	5.636	545	0.004 (Sig.)
H(m)	3.259	545	0.001(Sig.)

Independent Samples Test

Variables	t	df	p-value
DBH(cm)	4.554	545	0.000 (Sig.)
H(m)	2.553	545	0.001(Sig.)