Ethnobotany and Conservation of Plant Resources of Kainji Lake National Park, Nigeria

T.O. Amusa, S.O. Jimoh, P. Aridanzi and M. Haruna

Research

Abstract

The study was conducted to generate baseline data for the conservation and sustainable use of woody resources in Kainji Lake National Park. The study objectives were to document local knowledge on uses, status and sustainable management of selected woody species. Using both ethnobotanical and quantitative ecological methods, the study was carried out in the Borgu sector of the park. A total of 37 plants species belonging to 18 families were selected using a ranking and prioritization scale. Family-Fabaceae was the dominant family in terms of number of species represented. The species are multipurpose and are exploited to satisfy different subsistence needs. Among the plant-use categories, medicinal uses ranked highest (38%) followed by edible plants (25%), miscellaneous purposes (24%), and construction (13%). In terms of species status, *Detarium microcarpum* Guill. & Perr. has the highest mean frequency of 68.9% and a population density of 3.036 $\pm$ 1.7 individuals/ha. This is followed by *Vitellaria paradoxa* C.F. Gaertn. with 55.6% mean frequency and a population density of 2.143 $\pm$ 1.7 individuals/ha. There was no significant relationship between the useful value of a species and its density rank (R= 0.047; R^2 = 0.002; F= 0.783) in the study area. Thus, the study recommends a holistic approach that includes the involvement of the local people in the management of woody species.

Introduction

According to Plotkin (2006), ethnobotany is the study of the interaction between plants and people, with a particular emphasis on traditional tribal cultures. Connie and Steven (2005) described ethnobotany as the study of how people of a particular culture and region make use of indigenous plants, and how they classify, identify and relate to them.

Today, ethnobotany is in the midst of a renaissance. This revival reflects increasing concern about the disappearance of the rain forests and other biomes of the world, and the tribal cultures inhabiting them. It is common knowledge that a plant of known economic importance to a region is often not easily destroyed when clearing for agricultural and construction purposes. However, given the unprecedented influence of human interference on the plant world at both global and local levels, the need to conserve plant genetic resources cannot be over-emphasized. This is also coupled with the need to document indigenous knowledge of plant usage and the relationships with conservation. Both the Convention on Biological Diversity (CBD 1992) and the Global Strategy for Plant Conservation and Economic Development (Twarog & Kapoor 2004) have recognized this importance and placed a great emphasis on it.

However, indigenous knowledge of plant use is subject to numerous threats. Several economic and social factors contribute to these threats. These have been of great

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interest to those who believe that indigenous knowledge can contribute to the resolution of sustainability problems (Benz *et al*. 2000, Byers *et al*. 2001, Phillips & Gentry 1993). By contrast, not all threats to the loss of indigenous knowledge among local communities are anthropogenic. Among many potential causes of loss of knowledge could be ecological, including low population size, narrow distribution ranges, introduction of non-native species, habitat loss and alteration.

Protected areas represent a valuable starting point for studying relationships between indigenous knowledge of uses of plant species and their conservation status. Kainji Lake National Park is Nigeria's oldest park established in 1976 to foster the conservation of biodiversity resources of the Kainji Lake basin and its environment. As elsewhere, many indigenous people and local communities living within the region have developed a perception and use of the natural environment in a manner that plays an important role in their livelihood strategy and the conservation of biological resources. Historically, the protected area allowed restricted access to, and use of, the area's resources by local communities who formerly were dependent on these areas for their livelihood.

In spite of the fact that there have been several attempts to document the use of plants in several indigenous communities in Nigeria, there is a dearth of empirical information describing the linkages and relationships of traditional knowledge, use patterns and plant conservation issues with regard to the availability of the species used. In this study, we investigated the uses and status of selected woody species of Kainji Lake National Park with a view to understanding the pressures faced on plant species in this protected area and to suggest measures for future conservation and management approaches.

Materials and Methods

The Study area

The study area is Kainji Lake National Park (KLNP) and the support zone communities (Figure 1). KLNP is the premier park in Nigeria covering a total area of 5340.82 km^2 and composed of two non-contiguous sectors, the Borgu and Zugurma sectors. The Borgu sector with an area of 3970.02 km^2 is situated in Borgu (Niger State), Kaiama and Baruten (Kwara State) Local Government areas. The Zugurma sector, on the other hand, occupies an area of 1370.80 km^2 and situated in Mashegu Local Government area of Niger State. The two sectors are separated by the Kainji Lake, a lake impounded on the Niger river for hydroelectric power generation. The entire park lies between latitudes 9^o 40′ N and 10^o 23′ and longitudes 3^o 30′ and 5^o 50′ E (Tuna Wildlife Consultants & NARDES 1983).

The vegetation of the Borgu sector is a transitional one between the Sudan and Northern Guinea Savanna types, while that of the Zugurma sector is typically Northern Guinea Savanna woodland (Child 1974, DRB 2004, Milligan 1979). The vegetation of the Borgu sector is differentiable by hydrological as well as soil factors into six major types viz; the *Afzelia africana* woodland, the *Isoberlinia* woodland, the *Terminalia macroptera* woodland, the *Acacia* complex, the *Burkea africana* / *Detarium microcarpum* wooded savanna and the riparian or fringing forest (Child 1974). One other distinct vegetation type of limited size is also present; this is the *Diospyros mespiliformis* dry forest (Figure 2).

KLNP is home to a large pool of fauna resources which include; Lion (*Panthera leo* L.), Bush buck (*Tragelaphus scriptus* Pall.), Gambia mongoose (*Mungos gambianus* Ogilby), Hippopotamus (*Hippopotamus amphibius* L.), Western hartebeest (*Alcelaphus buselaphus* Pall.), Nile crocodile (*Crocodylus niloticus* Laurenti), Grey heron (*Ardea cinerea* L.), Stone partridge (*Ptilopachus petrosus* Gmelin), Guinea fowl (*Guttera pucherani* Hartlaub). The park is also reputed for abundant fishery resources such as; (*Labeo senegalensis* Valenciennes), Nile perch (*Lates niloticus* L.), Moustache Catfish (*Synodontis membranaceus* G. Saint-Hilaire), (*Alestes baremoze* Joannis), Lined Citharinid (*Citharinus citharus citharus* G. Saint-Hilaire).

The entire study area falls into a region that can aptly be described as rural (DRB 2004). Agriculture is the most important economic activity and engages more than 75 percent of the active labour force. Besides crop production, the people of the area also engage in fishing and livestock production. Increasing population and unrestrained anthropogenic activities are impacting negatively on the rich biodiversity of the area. Illegal grazing, poaching, burning, farming, fishing and general encroachment into protected areas are human activities threatening the protection of flora and fauna in the area.

Sampling

The study was conducted from November 2005 - August 2007. Fieldwork consisted of two parts: (1) an ethnobotanical survey based on interviews; and (2) a botanical survey based on sample plots. For the ethnobotanical survey, eight communities within thirty kilometers radius of the Park in the Borgu sector were randomly selected. Household surveys using structured and semi-structured questionnaires were conducted in the selected communities. This was done using systematic sampling (every 10th house). The respondent in each household was the head (male or female). In order to bring order and some level of precision a sampling intensity of 10% was adopted for the survey. In all 269 copies of questionnaires were administered by the research team (comprising of a female and three males). Table 1 shows the distribution of households and respondents among the communities.

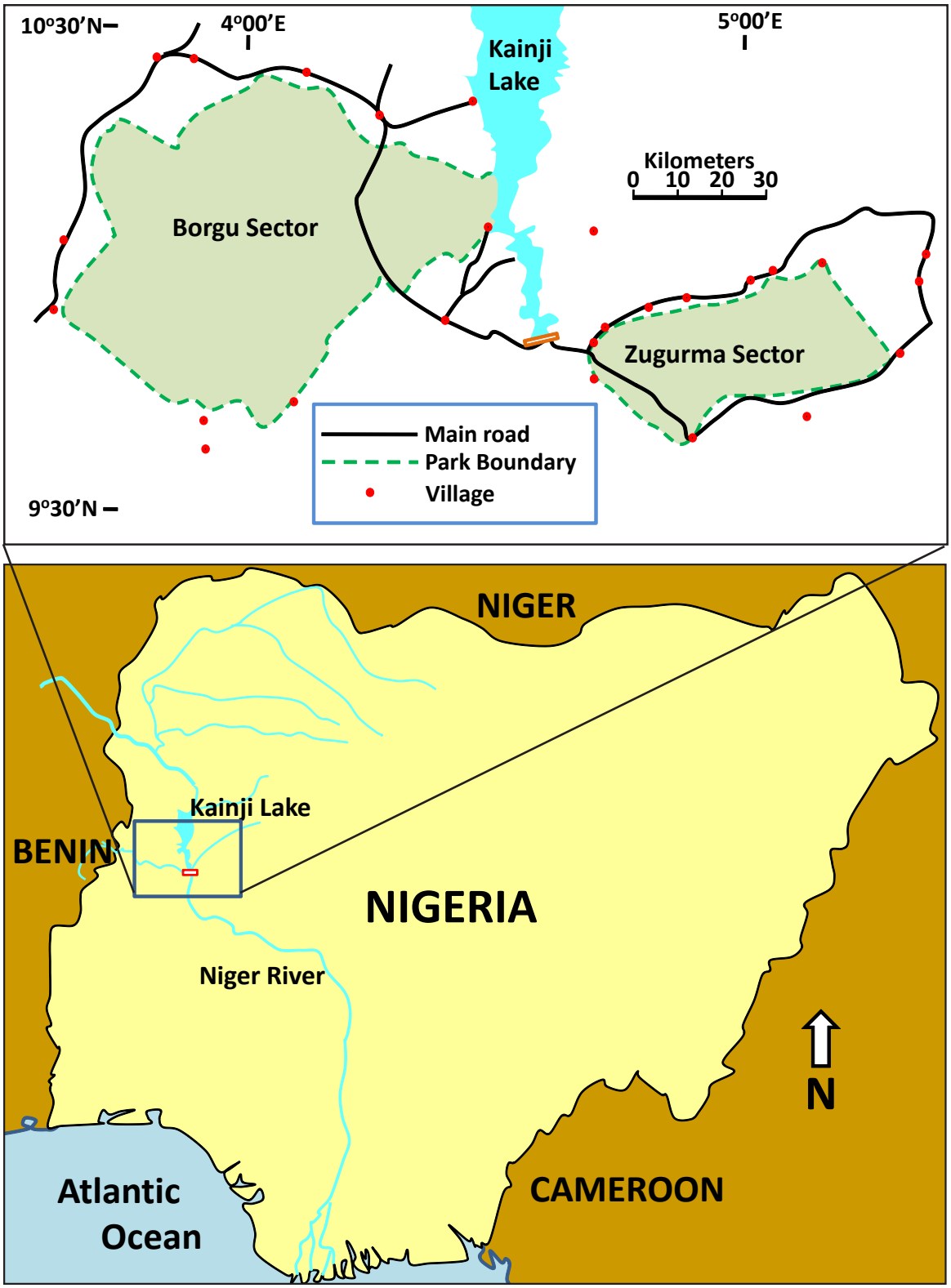

Figure 1. Kainji Lake National Park, Nigeria- Borgu and Zugurma sectors with the support zone communities.

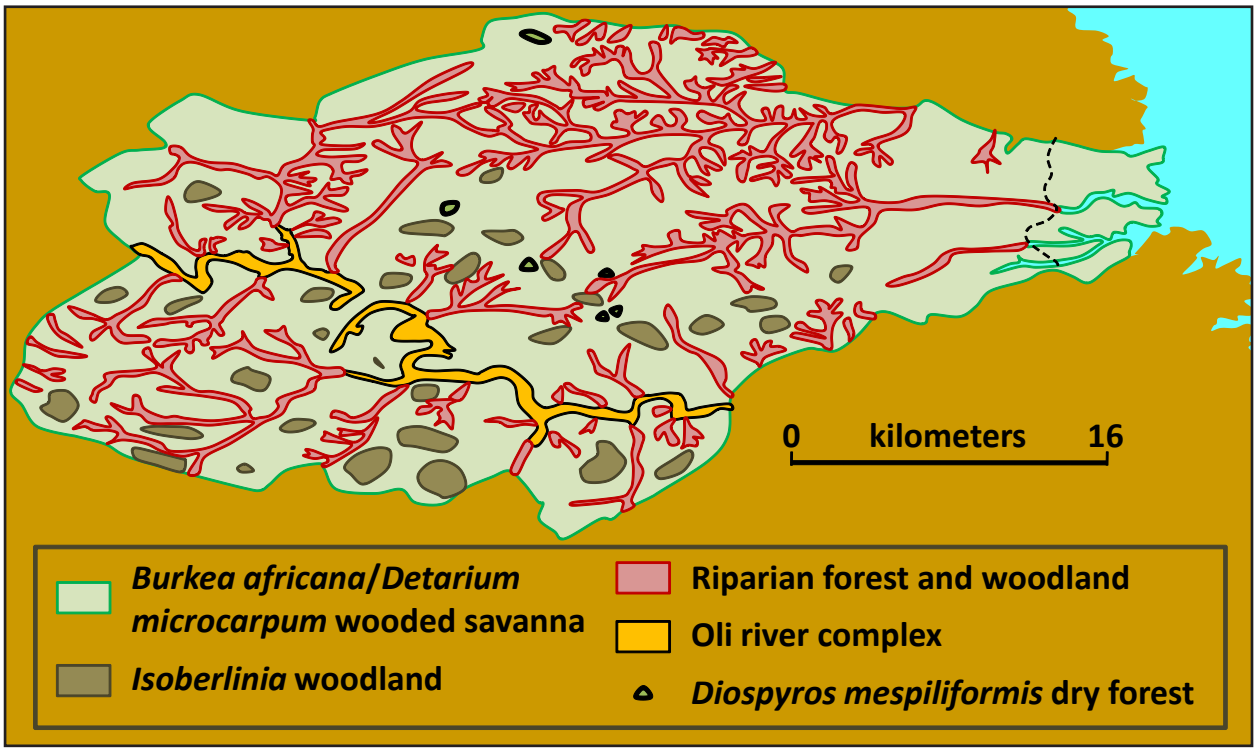

Figure 2. A generalized vegetation map of the Borgu sector, Kainji Lake National Park, Nigeria.

Table 1. Distribution of households and respondents in selected communities.

Communities	*Estimated Population	Estimated number of house-holds	10% random sampling
Wawa	6570	821	82
Doro	2150	269	27
Luma	1098	137	14
Babana	2500	313	31
Kemenji	2580	323	32
Duruma	2800	350	35
Kuble	1280	160	16
Kali	2550	319	32
TOTAL	**18728**	**2692**	**269**

*Data are based on the projected increase of 2.68% from the 1991 national population and house census.

We elicited additional information through focus group discussions (FGD) involving groups (male and female separately) comprising of 3-5 elders in each of the community. This medium provided opportunities for ranking and prioritization of species following Adeola *et al*. (1994). The species with the lowest average scores totaling 37, were selected for detailed studies to determine their ethnobotanical and conservation status in the study area (Table 2). Information on the different uses of each plant collected was gathered. Specifically, information on the uses of major plants of medicinal importance, their preparations and administrations (Table 3).

For the botanical survey, a stratified random sampling was used to select sample sites within the Borgu sector of the Park. This was done based on vegetation sub-classification as shown in Figure 2. A total of Fourteen (14) plots of 20m x 200m strips were carefully demarcated within the selected sites. In each plot a total of ten (10) 10m x 10m sub-plots were randomly selected for identification of plants found within each of the sub-habitat. Samples of plants collected from each of the sub-habitat were jointly identified with members of the community and taxonomists in the team using participatory rural appraisal techniques (Freudenthal & Narrowe 1991, McCracken *et al*. 1998). The voucher specimens were deposited at the Forestry Herbarium Ibadan. Frequency of each species was taken as a measure of its occurrence within the sub-plots. Data collected within plots were pooled, and the mean relative frequency and population density for each plant in the study area were calculated thus;

$$\text{Relative Frequency} = \frac{\text{Frequency of a species}}{\text{Sum of frequencies for all species}} \text{ X } 100$$

$$\text{Population Density} = \frac{\text{Total number of an individual species from all sampled plots}}{\text{Total Area of sample plots } (m^2)}$$

Table 2. Plants species studied for ethnobotanical and conservation status at Kainji Lake National Park, Nigeria.

Family	Species	Vernacular Names	
		Bissan	**Hausa**
Anacardiaceae	*Lannea acida* A. Rich.		**Faaru**
Annonaceae	*Annona senegalensis* Pers.	**Moshualii**	**Guadar dajii**
Bignoniaceae	*Kigelia africana* (Lam.) Benth.		**Pahina**
Bixaceae	*Cochlospermum tinctorium* A. Rich.		**Rawaya**
Burseraceae	*Boswellia dalzielii* Hutch.		**Ararrbi**
Celastraceae	*Maytenus senegalensis* (Lam.) Exell		**Namijin tsada**
Chrysobalanaceae	*Parinari polyandra* Benth.	**Blebona**	**Sassabani**
Combretaceae	*Anogeissus leiocarpus* (DC.) Guill. & Perr.		**Marike**
	Combretum molle R. Br. ex G. Don		**Ugadamo**
	Combretum nigricans Lepr. ex Guill. & Perr.		**Farataurania**
	Terminalia macroptera Guill. & Perr.		**Kandari**
	Terminalia schimperiana Hochst.	**Betieli**	**Baushe**
Ebenaceae	*Diospyros mespiliformis* Hochst. ex A. DC.		**Kanya**
Fabaceae	*Acacia seyal* Delile		**Dushe**
	Afzelia africana Sm.	**Birinlii**	**Kawo**
	Burkea africana Hook.	**Shapatali**	**Kolo**
	Daniellia oliveri (Rolfe) Hutch. & Dalziel	**Birni**	**Maje**
	Detarium microcarpum Guill. & Perr.	**Wawalii**	**Taura**
	Entada africana Guill. & Perr.		**Tawaosa**
	Isoberlinia doka Craib & Stapf		
	Parkia biglobosa (Jacq.) R. Br. ex G. Don		**Doruwa**
	Piliostigma thonningii (Schumach. & Thonn.) Milne-Redh.	**Bakalali**	**Kalugo**
	Prosopis africana (Guill. & Perr.) Taub.		**Kiriya**
	Pterocarpus erinaceus Poir.		**Madobia**
	Tamarindus indica L.	**Tsamalii**	**Tsaamiyan**
Lamiaceae	*Vitex doniana* Sweet	**Kuun**	**Dainyaa**
Loganiaceae	*Strychnos spinosa* Lam.		**Kokiya**
Malvaceae	*Adansonia digitata* L.		**Kuka**
	Grewia mollis Juss.		**Dargaji**
	Sterculia setigera Delile	**Potcelii**	**Kukuki**
Meliaceae	*Khaya senegalensis* (Desr.) A. Juss.		**Madacii**
Olacaceae	*Ximenia americana* L.		**Jimikar firi**
Phyllanthaceae	*Bridelia ferruginea* Benth.	**Daalii**	**Kishi**
Rubiaceae	*Crossopteryx febrifuga* (Afzel. ex G. Don) Benth.	**Kaafiya**	**Kachi awaki**
	Gardenia aqualla Stapf & Hutch.		**Gaudar dajii**
	Nauclea latifolia Sm.	**Nabich biri**	**Kokia**
Sapotaceae	*Vitellaria paradoxa* C.F. Gaertn.		**Kaadanya**

Table 3. Medicinal plants and their used studied through interviews at Kainji Lake National Park, Nigeria.

Species	Part used	Ailment treated	Preparation	Administration
Acacia seyal Delile	bark	Toothache, body pain	Bark is cooked alone	Fluid is drunk
Adansonia digitata L.	bark	Toothache, cough	Bark is soaked in water	By drinking and bathing with water
Annona senegalensis Pers.	leaf	Wounds	Young shoots and leaves are squeezed to generate juice	Juice applied on affected area of wounds
Anogeissus leiocarpus (DC.) Guill. & Perr.	bark	Stomachache and worms	Bark is dried, ground, then boiled	Fluid is drunk
Boswellia dalzielii Hutch.	bark, leaf	Piles, stomach-ache and worms	Bark is dried, pounded then soaked in water. Leaves and bark may be boiled together	Fluid is used for bathing twice a day
Bridelia ferruginea Benth.	root, stem	Dysentery, whooping cough	Root is cooked. Stem is chewed	Alligator pepper* is inserted in the stem and chewed
Burkea africana Hook.	leaf, bark	Stomachache, body weakness and joint pain	Bark and leaves are boiled together or the bark is soaked alone	Fluid is used for bathing. The soaked bark is drunk
Combretum nigricans Lepr. ex Guill. & Perr.	root	Rheumatism	Roots are ground and mixed with potash	Applied on affected area
Crossopteryx febrifuga (Afzel. ex G. Don) Benth.	fruit, bark	Reviving domestic animals; Stomach disorders	Fruit is ground and mixed with potash. Bark is cooked with potash	A dying animal is revived by drinking this concoction
Daniellia oliveri (Rolfe) Hutch. & Dalziel	bark	Dysentery	Bark is soaked in water	Fluid is drunk
Detarium microcarpum Guill. & Perr.	bark, root, leaf	Dysentery, joint pain	Bark and roots are cooked together. Leaves are cooked alongside other plants	Fluid is used for bathing and is also drunk
Entada africana Guill. & Perr.	root	Gonorrhea, piles and worms	Roots are cooked alone	Fluid is drunk
Grewia mollis Juss.	bark	Cuts and wounds	Bark is pounded with the addition of a little water	Applyed fresh, directly on the affected area
Khaya senegalensis (Desr.) A. Juss.	bark	Piles and stomachache	Bark is pounded and soaked in water	Fluid is drunk
Kigelia africana (Lam.) Benth.	root, bark, fruit	Reduction of high blood pressure, stomach ache, yellow fever	Roots, bark and fruit are peeled and cooked to make a concoction	The concoction is drunk
Lannea acida A. Rich.	bark	Blood tonic	Bark is soaked in water	Fluid is drunk daily
Maytenus senegalensis (Lam.) Exell	root, leaf	Toothache	Root and leaves are cooked together	Fluid is used to wash mouth both morning and night
Nauclea latifolia Sm.	root, leaf	Waist and back pain	Root is boiled in water	Fluid is used to bath and drink

Species	Part used	Ailment treated	Preparation	Administration
Parinari polyandra Benth.	leaf, bark	venereal disease (such as syphilis)	Leaves and bark are cooked together	Fluid drunk or bark chewed
Parkia biglobosa (Jacq.) R. Br. ex G. Don	root	Yellow fever	Root cooked with potash	Fluid is drunk
Piliostigma thonningii (Schumach. & Thonn.) Milne-Redh.	leaf, root	Back ache, dysentery, cough and piles	Leaves and roots are cooked with ginger and alligator pepper*	Bathe and drink the fluid. For piles soak sitting in the fluid of the prepared concoction
Prosopis africana (Guill. & Perr.) Taub.	leaf, stem	Toothache	Leaves and stem cooked together, or cut stem is chewed	Fluid drunk or stem chewed
Pterocarpus erinaceus Poir.	bark	Unsteady menstruations, blood tonic	Bark boiled with potassium	Fluid is drunk
Sterculia setigera Delile	bark	Increase blood in the body	Bark cooked	Fluid is drunk morning and night
Strychnos spinosa Lam.	root	Hernia	Root dried with other plant species and ground into powdery form	Mixed with pap and drunk.
Tamarindus indica L.	fruit	Ease digestion	Fruit soaked in water until dissolved	Fluid is drunk
Terminalia macroptera Guill. & Perr.	bark	Cough	Bark dried, ground and mixed with water	Fluid is drunk
Terminalia schimperiana Hochst.	roots	Venereal diseases such as gonorrhea	Roots boiled with potassium	Fluid is drunk
Vitellaria paradoxa C.F. Gaertn.	seed, bark	Dislocation, body pain, stomachache, dysentery	Seed processed into cream. Bark cooked as concoction.	Cream used to massage affected area. Concoction drunk
Vitex doniana Sweet	leaf, bark	Stomachache	Leaves and bark boiled together	Fluid is drunk

* Alligator pepper (*Aframomum melegueta* K. Schum.)

We examined the relationship between usefulness of a plant and its mean density. Simple linear regressions were done of usefulness against density rank. Use value was calculated by adding up number of uses of a species (Boom 1990). Uses were hierarchically ordered. Thus, uses in each category and multiple uses (uses in more than one category) were treated separately. The analysis was done using Statistical Package for Social Sciences (SPSS 2001).

Results

Utilization categories of selected plant species

Family distribution of selected species shows that Fabaceae was the most dominant family in terms of number of species represented. This was followed by Combretaceae, Malvaceae and Rubiaceae in that order. Most of these species have multiple uses, an observation similar to the report of Kala (2005) and Akinsoji (2003). Among the plant-use categories, medicinal uses rank the highest (38%) followed by edible plants (25%) and miscellaneous purposes (24%). Plants used for construction purposes occupy 13% of use categories.

Medicinal plants

Information on the medicinal plants of Kainji Lake National Park is presented in Table 3. This includes; local names, types of ailments treated, parts of plant used, preparations and administration procedures. About twenty-seven (27) ailments were recorded. Of striking note is the use of *Crossopteryx febrifuga* (Afzel. ex G. Don) Benth. for the revival of dying domestic animals. Most plants are used

for treating more than one ailment, while preparations often involve the inclusion of ancillary items such as alligator pepper (*Aframomum melegueta* K. Schum.), potash and ginger (*Zingiber officinale* Roscoe). The most widely used parts of the plants in this region are the bark, followed by the leaves and roots. Seeds and fruits are not commonly used in preparations of decoctions for treating ailments. The mode of administration ranges from drinking or bathing with the preparations, chewing and sitting atop the prescription among others.

Table 4. Edible plants in the Borgu Sector of Kainji Lake National Park, Nigeria.

Species	Parts of plant eaten				
	Leaf	Fruit	Seed	Bark	Root
Adansonia digitata L.	**L**	**F**			
Afzelia africana Sm.			**S**		
Annona senegalensis Pers.		**F**			
Bridelia ferruginea Benth.			**S**		
Cochlospermum tinctorium A. Rich.					**R**
Combretum molle R. Br. ex G. Don			**S**		
Combretum nigricans Lepr. ex Guill. & Perr.	**L**				
Detarium microcarpum Guill. & Perr.		**F**			
Diospyros mespiliformis Hochst. ex A. DC.		**F**			
Gardenia aqualla Stapf & Hutch.		**F**			
Nauclea latifolia Sm.		**F**			
Parkia biglobosa (Jacq.) R. Br. ex G. Don		**F**	**S**		
Prosopis africana (Guill. & Perr.) Taub.		**F**			
Sterculia setigera Delile		**F**			
Strychnos spinosa Lam.		**F**			
Terminalia macroptera Guill. & Perr.		**F**	**S**		
Vitellaria paradoxa C.F. Gaertn.		**F**	**S**		
Vitex doniana Sweet		**F**			
Ximenia americana L.		**F**			

Edible plants

Table 4 reveals that some of the identified plants of Kainji Lake National Park are used as food items by local people. Nineteen (19) of 37 species discussed in this study are eaten. The most widely consumed parts of the plants are the fruits. For example, the leaves of *Adansonia digitata* L. are ground into a powdery form to prepare a locally popular soup called **kuka**. *Parkia biglobosa* (Jacq.) R. Br. ex G. Don, *Cochlospermum tinctorium* A. Rich. and *Vitellaria paradoxa* C.F. Gaertn., are used as additives, spices and a cooking oil source respectively. Some fruits such as *Vitex doniana* Sweet, *Diospyros mespiliformis* Hochst. ex A. DC., *Parkia biglobosa* (Jacq.) R. Br. ex G. Don and *Vitellaria paradoxa* C.F. Gaertn. are harvested and sold in the market mostly by women and children to augment family income.

Table 5. Plants used for construction purposes in the Borgu Sector of Kainji Lake National Park, Nigeria.

Species	Part used	Purpose	
		Timber	Rope
Acacia seyal Delile	bark		**R**
Afzelia africana Sm.	wood	**T**	
Anogeissus leiocarpus (DC.) Guill. & Perr.	wood, stem	**T**	
Burkea africana Hook.	wood	**T**	
Cochlospermum tinctorium A. Rich.	stem		**R**
Daniellia oliveri (Rolfe) Hutch. & Dalziel	wood	**T**	
Isoberlinia doka Craib & Stapf	wood	**T**	
Khaya senegalensis (Desr.) A. Juss.	wood	**T**	
Piliostigma thonningii (Schumach.& Thonn.) Milne-Redh.	bark		**R**
Vitex doniana Sweet	wood	**T**	

Plants used for construction purposes

From Table 5, ten (10) plant species out of the 37 studies from Kainji Lake National Park are used for construction purposes. The most common part used is wood. The bark of *Piliostigma thonningii* (Schumach.& Thonn.) Milne-Redh. is used as rope to tie farm products and to tie pieces of wood together for roofing. Plants like *Isoberlinia doka* Craib & Stapf, *Daniellia oliveri* (Rolfe) Hutch. & Dalziel and *Khaya senegalensis* (Desr.) A. Juss. are used

Table 6. Miscellaneous uses of plants in the Borgu Sector of Kainji Lake National Park, Nigeria.

Species	Parts Used	Uses				
		Shade	Chewing stick	Ink	Potash	Fuel wood
Acacia seyal Delile	stem					**FW**
Afzelia africana Sm.	wood, canopy	**S**				**FW**
Anogeissus leiocarpus (DC.) Guill. & Perr.	wood, branches					**FW**
Burkea africana Hook.	wood, branches					**FW**
Crossopteryx febrifuga (Afzel.ex G. Don) Benth.	wood		**CS**			
Daniellia oliveri (Rolfe) Hutch. & Dalziel	wood	**S**				**FW**
Detarium microcarpum Guill. & Perr.	branches, stem					**FW**
Diospyros mespiliformis Hochst. ex A. DC.	stem		**CS**			
Isoberlinia doka Craib & Stapf	wood, canopy	**S**				**FW**
Khaya senegalensis (Desr.) A. Juss.	wood	**S**				**FW**
Lannea acida A. Rich.	whole plant	**S**				**FW**
Parinari polyandra Benth.	wood					**FW**
Piliostigma thonningii (Schumach.& Thonn.) Milne-Redh.	stem					**FW**
Prosopis africana (Guill. & Perr.) Taub.	stem		**CS**			
Terminalia macroptera Guill. & Perr.	stem, wood		**CS**		**P**	
Vitex doniana Sweet	wood			**I**		

as timber in furniture and household items such as chairs, benches, stools, mortars and pestles.

Plants used for miscellaneous purposes

Several plants of Kainji Lake National Park still serve some other purposes that are crucial to human survival (Table 6). Most plants are used as fuel-wood for household energy generation. This also serves as a means of generating income to fuel-wood marketers. The matured fruits of *V. doniana* are also used as ink by extracting the juice from the fruits. *T. macroptera* is also reputed to be the best in potash production among the local communities.

Status of woody plants in the Borgu Sector of Kainji Lake National Park

Table 7 shows the mean relative frequency and population density of plants in the study area. *Detarium microcarpum* has the highest mean frequency represented with 68.9% and a population density of 3.036 $\pm$ 1.7 individuals/ha. This is followed by *V. paradoxa* with 55.6% mean frequency and a population density of 2.1 $\pm$ 1.7 individuals/ha. The plant with the least mean frequency is *Kigelia africana* (Lam.) Benth. with 5.3% and a population density of 0.004 $\pm$ 0.3 individuals/ha.

Abundance Classification Scheme for Plants In Borgu Sector Of Kainji Lake National Park

The abundance classification scheme presented in table 8 indicates that, out of the thirtyseven (37) plants, only three (3) species fall in the very abundant category. Two (2) species are categorized as simply abundant while thirteen (13) and twelve (12) others fall in the frequent and occasional category respectively. Similarly, five (5) species are rated as rare and two (2) are very rare.

Regression Analysis of Relationship between Plant usefulness and density rank

The model summary data is presented in Table 9. The R value of 0.047 for the multiple correlation coefficient indicates a weak relationship between the predictor variable (density rank) and the dependent variable (usefulness). R^2 (0.002) coefficient of determination, shows that an insignificant proportion of the variation observed is explained by the model. The significance value of the F sta-

Table 7. Mean relative frequency and population density of plants in the Borgu Sector of Kainji Lake National Park, Nigeria.

Species	Relative Frequency (%)	Mean Density (Individual /ha)	Density Rank
Acacia seyal Delile	20.11	0.018 ± 0.053	29
Adansonia digitata L.	12.08	0.002 ± 0.190	35
Afzelia africana Sm.	25.43	0.089 ± 0.560	17
Annona senegalensis Pers.	34.99	0.893 ± 1.140	9
Anogeissus leiocarpus (DC.) Guill. & Perr.	32.57	0.179 ± 0.400	13
Boswellia dalzielii Hutch.	16.53	0.011 ± 0.053	31
Bridelia ferruginea Benth.	32.85	0.257± 0.720	12
Burkea africana Hook.	43.01	1.607 ± 0.910	4
Combretum molle R. Br. ex G. Don	53.89	1.786 ± 1.200	3
Combretum nigricans Lepr. ex Guill. & Perr.	41.20	1.429 ± 0.360	6
Cochlospermum tinctorium A. Rich.	41.70	1.543 ± 0.640	5
Crossopteryx febrifuga (Afzel.ex G. Don) Benth.	31.51	0.125 ± 0.600	15
Daniellia oliveri (Rolfe) Hutch. & Dalziel	21.94	0.026 ± 1.930	22
Detarium microcarpum Guill. & Perr.	68.89	3.036 ± 1.680	1
Diospyros mespiliformis Hochst. ex A. DC.	33.00	0.036 ± 2.960	20
Entada africana Guill. & Perr.	20.47	0.019 ± 0.220	27
Gardenia aqualla Stapf & Hutch.	24.68	0.054 ± 1.030	19
Grewia mollis Juss.	32.23	0.161± 0.670	14
Isoberlinia doka Craib & Stapf	16.10	0.009 ± 0.680	33
Khaya senegalensis (Desr.) A. Juss.	18.15	0.016 ± 0.210	30
Kigelia africana (Lam.) Benth.	5.30	0.004 ± 0.230	37
Lannea acida A. Rich.	20.24	0.019 ± 1.100	28
Maytenus senegalensis (Lam.) Exell	38.86	1.250 ± 2.010	7
Nauclea latifolia Sm.	25.42	0.071± 0.090	18
Parinari polyandra Benth.	16.15	0.010± 0.087	32
Parkia biglobosa (Jacq.) R. Br. ex G. Don	37.10	1.071± 0.190	8
Piliostigma thonningii (Schumach.& Thonn.) Milne-Redh.	32.92	0.536 ± 0.570	11
Pterocarpus erinaceus Poir.	20.72	0.020 ± 0.000	26
Prosopis africana (Guill. & Perr.) Taub.	21.83	0.025 ± 0.560	24
Sterculia setigera Delile	13.59	0.005 ± 0.070	34
Strychnos spinosa Lam.	33.93	0.714 ± 0.970	10
Tamarindus indica L.	21.85	0.025 ± 0.410	23
Terminalia macroptera Guill. & Perr.	21.08	0.022 ± 0.510	25
Terminalia schimperiana Hochst.	28.23	0.107 ± 2.680	16
Vitellaria paradoxa C.F. Gaertn.	55.58	2.143 ± 1.670	2
Vitex doniana Sweet	22.26	0.028 ± 0.520	21
Ximenia americana L.	7.46	0.014 ± 0.890	36

Table 8. Abundance classification scheme for plants in Borgu Sector of Kainji Lake National Park, Nigeria.

Species list	Very abundant	≥ 50%	Abundant	≥40 <50%	Frequent	≥30 <40%	Occasional	≥20 <30%	Rare	≥10 <20%	Very rare	<10%
Acacia seyal Delile							X					
Adansonia digitata L.									X			
Afzelia africana Sm.							X					
Annona senegalensis Pers.					X							
Anogeissus leiocarpus (DC.) Guill. & Perr.					X							
Boswellia dalzielii Hutch.							X					
Bridelia ferruginea Benth.					X							
Burkea africana Hook.			X									
Combretum molle R. Br. ex G. Don	X											
Combretum nigricans Lepr. ex Guill. & Perr.			X									
Cochlospermum tinctorium A. Rich.					X							
Crossopteryx febrifuga (Afzel.ex G. Don) Benth.							X					
Daniellia oliveri (Rolfe) Hutch. & Dalziel							X					
Detarium microcarpum Guill. & Perr.	X											
Diospyros mespiliformis Hochst. ex A. DC.					X							
Entada africana Guill. & Perr.							X					
Gardenia aqualla Stapf & Hutch.					X							
Grewia mollis Juss.					X							
Isoberlinia doka Craib & Stapf									X			
Khaya senegalensis (Desr.) A. Juss.									X			
Kigelia africana (Lam.) Benth.											X	
Lannea acida A. Rich.							X					
Maytenus senegalensis (Lam.) Exell					X							
Nauclea latifolia Sm.							X					
Parinari polyandra Benth.									X			
Parkia biglobosa (Jacq.) R. Br. ex G. Don					X							
Piliostigma thonningii (Schumach.& Thonn.) Milne-Redh.					X							
Pterocarpus erinaceus Poir.							X					
Prosopis africana (Guill. & Perr.) Taub.							X					
Sterculia setigera Delile									X			
Strychnos spinosa Lam.					X							
Tamarindus indica L.							X					
Terminalia macroptera Guill. & Perr.							X					
Terminalia schimperiana Hochst.					X							
Vitellaria paradoxa C.F. Gaertn.	X											
Vitex doniana Sweet					X							

Table 9. Model summary for plants used in the Borgu Sector of Kainji Lake National Park, Nigeria.

Model	R	R Square	R Square Adjusted	Std. Error of the Etimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.047	.002	-.026	1.44020	.002	.077	1	35	.783	1.653

a. Predictors: (Constant), VAR00001
b. Dependent Variable: VAR00002

tistic (0.783) is greater than 0.05, which means that the variation explained by the model is due to chance.

Discussion

Many studies have analyzed indigenous knowledge of plant use among different communities (e.g., Kala 2005, Rijal 2008). In this study, indigenous communities living in the support zones of Kainji Lake National Park have learned to utilize the resources around them in many ways. Four categories of use were identified viz; food, medicine, construction and miscellaneous.

Ethnomedicinal knowledge of plants

The study reveals that medicinal plants account for a larger proportion of respondents' dependence on the protected area. This could be attributed to the fact that the primary occupation in the study area is agriculture, largely farming activities which in effect reduced the need for forest foods. As noted by Kiringe (2005), use of traditional medicine is prevalent among rural communities of Africa. They have immense knowledge on ethnomedicine, although its use is rapidly diminishing partly due to lifestyle changes and exposure to Western ideologies. Twenty-seven ailments from thirty species have been documented in this study, with some species overlapping in the treatment of the same ailment. This observation is similar to the reports of Kala on traditional knowledge systems of plants in India (Kala 2005). Generally, several factors persist to account for dependency on traditional medicine. Traditional medicine unlike modern medicine is an integral component of many cultures which has evolved for many generations, and it is considered effective in treating and managing certain cultural health problems (Sindiga 1994). It is also considered efficacious, readily acceptable by the community and as well holistic in its approach to addressing health problems. Further, it is cost effective and traditional healers charge affordable fees. It is also readily available and accessible to rural communities even where infrastructure is poor (Phillips 1985, Pillsbury 1979, Sindiga 1994, WHO 1978). Dependence on traditional medicine can also be attributed to a strong attachment to traditional lifestyle, high level of poverty in the community, remoteness of area coupled by very poor infra-structure which makes access to modern health facilities difficult. Also, most rural communities of Africa do not see any danger associated with the use of herbal remedies. In fact, initial home treatment of sick persons using herbal remedies is a common practice among African communities (Brown 1995, Iwu 1993, Sindiga *et al*. 1995). The mention of *C. febrifuga* for the revival of dying domestic animals in this study shows the intricate skills and knowledge communities have acquired in the use of plant resources.

Meanwhile, some of the medicinal plants in this study are considered occasional and rare (Table 8). This raises concern about the need for both short and long term intervention strategies to save the species into the future. There is indeed an urgent need for an official policy for developing and upgrading local plants used as source of medicines to complement orthodox therapy in Nigeria. More so, over 80% of Nigerians are reported to depend on herbal medicines (Ugbogu 2005), while modern healthcare is still beyond the reach of a good proportion of the rural population.

Plants used for food, construction and miscellaneous purposes

The use values of the studied species transcend medicinal importance. Large quantities of the species are also utilized for food, construction, fuelwood and miscellaneous purposes such as ink, potash and chewing sticks. Over exploitation and commercial sale of some of the species is already threatening the long term availability of a significant portion of such species, particularly *D. microcarpum* and *V. paradoxa* both of which are valued for firewood and charcoal purposes. Interestingly, these two species are still in abundance and have the highest density ranks and mean frequencies among studied species (Table 7). Nevertheless, an increasing number of reports have documented the over-harvest of non-timber forest products (NTFPs) and the negative effects on plant and animal populations in many nature reserves (Bhatnagar 2002, Shahabuddin & Prasad 2004, Ticktin 2004). It is therefore, imperative that the extent and impacts of exploitation of these species be studied to elucidate the need for enhanced conservation and also to guarantee the livelihoods of the people. Further, the development of these groups of plants could serve as a basis for the implementation of a program aimed at encouraging local community involvement in the protection and management of the park. This is more important given the fact that the buffer zone of the park is seriously being encroached into by local communities and other settlers from neighbouring States.

Status of selected plant species

In terms of species density and abundance, only three species consisting of *Combretum molle* R. Br. ex G. Don, *D. microcarpum* and *V. paradoxa* ranked high and very abundant (≥ 50% in occurrence). Closely following these species are *Burkea africana* Hook. and *Combretum nigricans* Lepr. ex Guill. & Perr., which are classified as simply abundant (≥ 40 %< 50%). Other species are poorly represented. However, there was no significant relationship between the useful value of a species and its density rank. This observation tends to suggest that exploitation is not the only key threat to continued availability of a species. Indeed, studies have indicated that the effects of harvest on both individuals and populations of a given species are highly variable and are mediated by different sources of variation including: variation in plant part and life history; variation in environmental conditions; variation due to management; variation in harvest method and; variation in land-use context (Siebert 2004, Ticktin 2004).

Extraction of certain species of plants from protected areas has been viewed as a conservation strategy based on the argument that forest conservation must be able to offer economic incentives to local rural people to counter the threat from destructive land uses such as logging and cattle ranching (Ticktin 2004). It has also been reported that local people not only exploit their bio-resources for meeting basic needs, but are also aware of the consequences of ruthless exploitation and have thus evolved their own means of sustainable exploitation of these resources (Bish *et al*. 2006). However, up scaling demand for plant raw material coupled with handsome incentives associated with increased extraction might lead to over exploitation of the same resources for short-term gain.

Conclusion

Communities living at forest margins and other woodland areas use forest resources in various ways. Understanding the resource-use patterns of such communities provides a basis for seeking their participation in forest and woodland conservation. Given the preceeding findings of this study, it is clear that the protection of biodiversity, which is one of the management objectives of the KLNP, will not be best achieved by precluding the local communities. In essence, embracing the paradigm shift of participatory management and integrating the aspirations of the local populace to the very existence of the Park will be a more effective way of enlisting their support in biodiversity management and protection. Furthermore, there is the need to devise sustainable harvesting techniques for wild populations of plant species from buffer zone areas in order to address the demand of the local people. Indeed, giving stewardship of natural resources to local people and encouraging profitable uses of those resources may provide a powerful incentive for conservation. Although, we did not establish any correlation between the useful value of a species and its density rank, it will not be out of place on the part of government and Park management authority to establish woodlots and arboreta for the supply of fuel wood and deliberate cultivation of medicinal plants and other non-timber forest products in need by the support zone communities. Sustainable harvesting combined with cultivation can help improve yields of harvested species in buffer zones, and it may reduce pressure on protected areas.

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