Obunga

[redacted]

Draft Copy

SUSTAINABLE DEVELOPMENT OF WOODCARVING INDUSTRY IN KENYA

TECHNICAL PROGRESS REPORT

PHASE II: RESOURCE ASSESSMENT (JANUARY - JUNE 1996)

By

Raymond Obunga[1]
and
Gordon Sigu[2]

[1] Herbarium Department
National Museums of Kenya
P.O Box 40658
Nairobi

[2] Forest Inventory and Mensuration Division
Kenya Forestry Research Institute
P.O Box 20412
Nairobi

CONTENTS

LIST OF FIGURES

[redacted]

LIST OF ACRONYMS

a.s.l	above sea level
BD	Basal Diameter
DBH	Diameter at Breast Height
Ha.	Hactare
IPR	Institute of Primate Research
JILO	International Labour Organization
KEFRI	Kenya Forestry Research Institute
KIFCON	Kenya Indigenous Forest Conservation Project
KCCU	Kenya Crafts Co-operative Union
MCC	Mennonite Central Committee
NMK	National Museum of Kenya
UK	United Kingdom
UNESCO	United Nations Educational Scientific and Cultural Organization
WWF	World Wildlife Fund for Nature

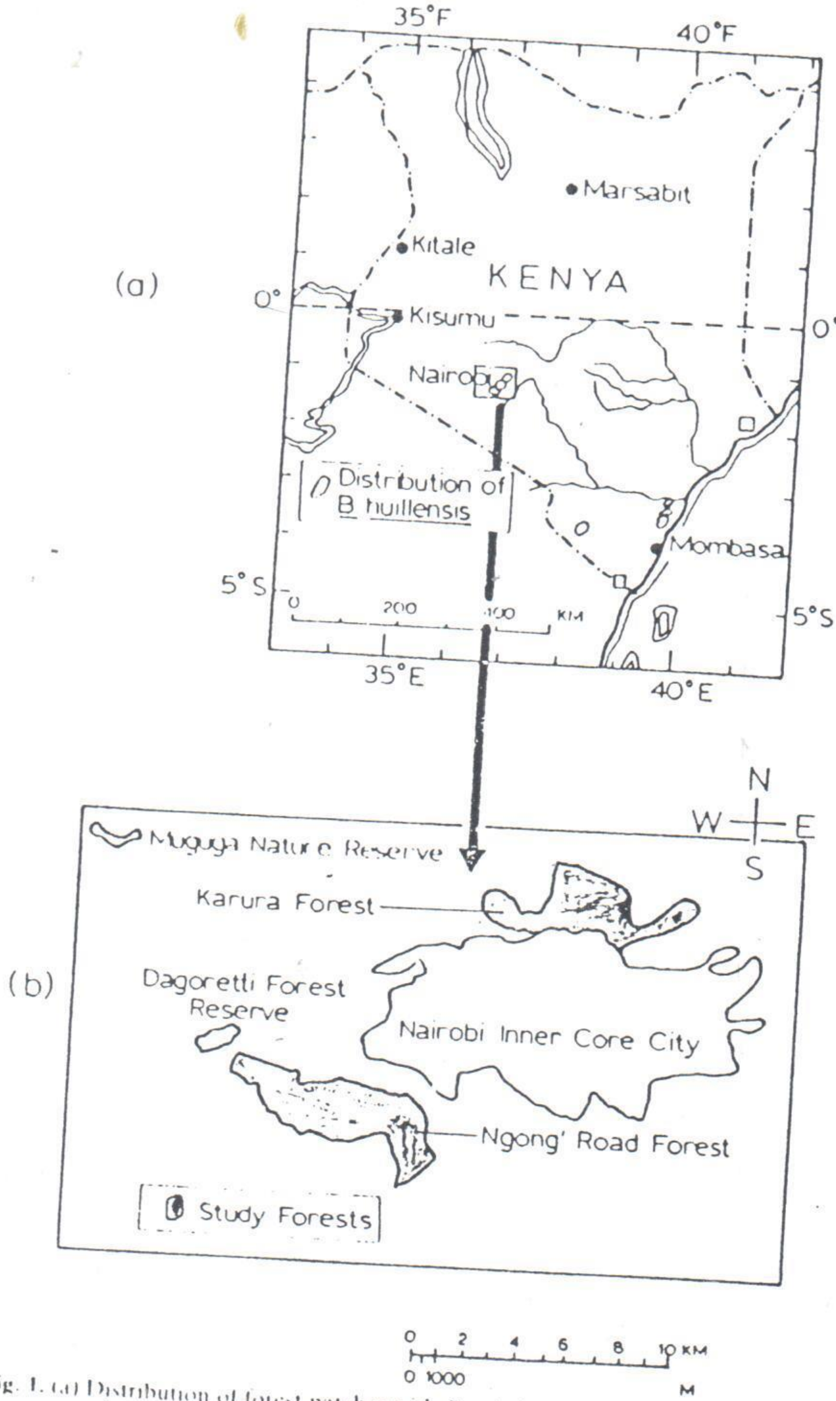


Fig. 1. (a) Distribution of forest patches with *Brachylaena huillensis*. (b) Location of the main study forest areas

Source: Kigomo (1990).

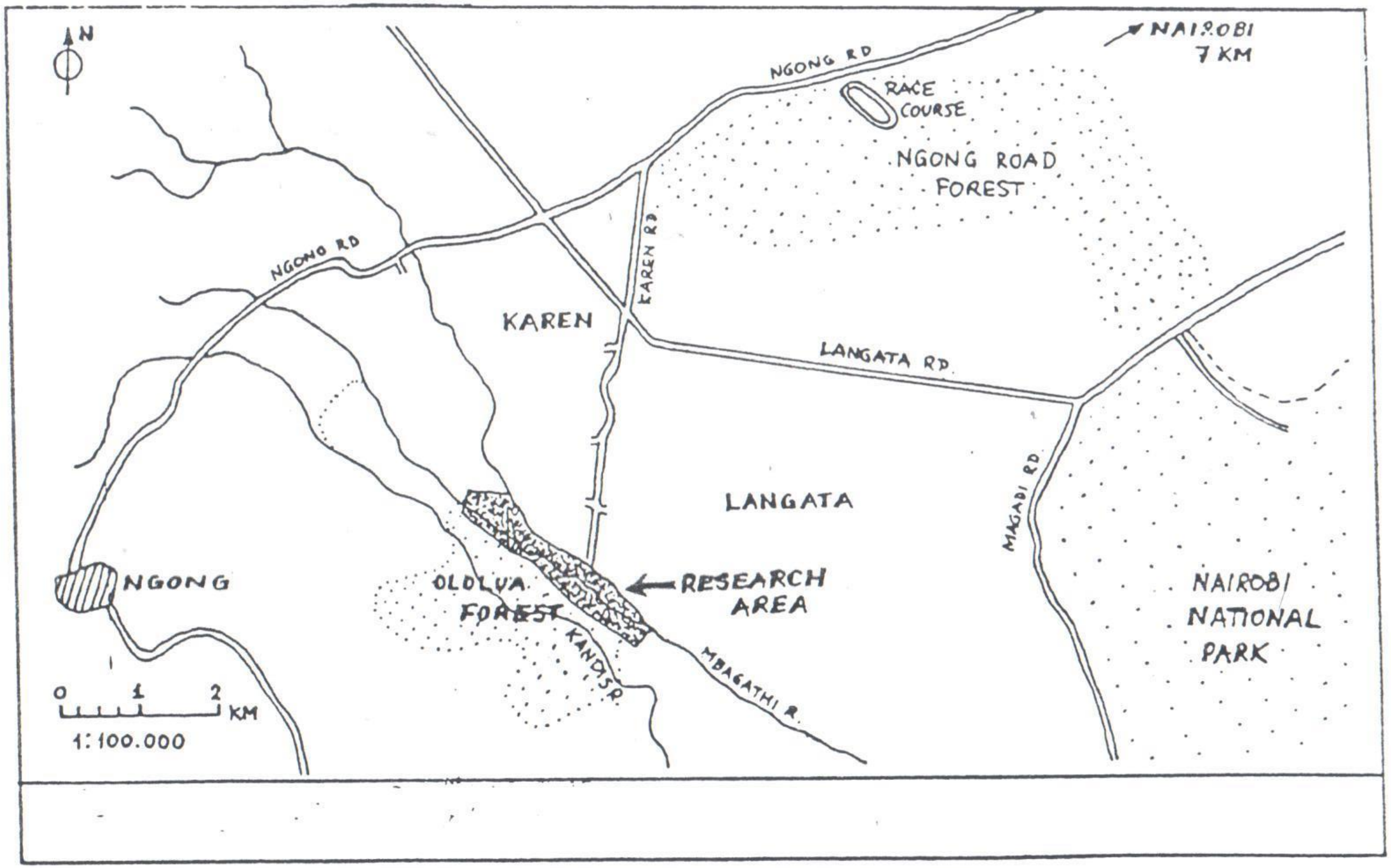


Fig. 2: The Location of Ololua and Ngong Road Forest.
Source: Doute (1976)

SUMMARY

Wood carving is the most important component of the handicrafts industry in Kenya. As a cottage industry, it provides self-employment and supplements incomes from subsistence agriculture in the rural areas. Overall in Kenya, the industry supports some 300,000 people and accounted for over Ksh. 100 million in exports earnings in 1994. Conservation and long term utilization of tree species used for carving require that they be harvested on a sustainable basis. However, the extent to which carving tree species are exploited without adverse effects on natural population is not known.

This study therefore attempts to assess the impacts of human and livestock on the population structure and regeneration potentials of *Brachylaena huillensis* as a key carving hardwood species from three Central Kenya upland dry forests, namely Ngong, Karura and Ololua, all near Nairobi. Data was recorded in randomly selected 0.04 ha. plots for diameter size class distributions (dbh), basal diameters of felled individuals, height of cut, method of cut, approximate age of cut, and stem diameters of established seedlings, saplings and coppices. These parameters of population structure and dynamics indicate a reduction in the population of merchantable (> 30 cm dbh) size classes, with most of the large trees remaining in the forest having poor stem forms. Data further showed that there is a correlation between height of cut and the method used. All large diameter classes (> 74 cm dbh) cut lower than 40 cm height were by power saw, presumably for industrial use. Karura forest had the highest number of these large diameter size classes.

Intensive and adverse impacts on *Brachylaena huillensis* were recorded and observed in Ngong Road Forest and the Kibera block where all diameter/ age class sizes were felled mainly for use as firewood and construction material in the nearby sprawling urban slum. Evidence of intensive disturbance by livestock browsing and trampling on the juvenile plants were observed in both Kibera and Ololua forest. All the 3 forests are undergoing rapid conversions into agricultural farms, settlements as well as other urban-related developments. At the current levels of utilization and impact, supply cannot satisfy the high demand for the species. This study raises concern that in order to attain sustainability, total control against further exploitation should be advocated for while experimentation with alternative species more abundant and quick growing continue.

Key Words: Wood carving, *Brachylaena huillensis*, population structure, regeneration, impact, sustainability, Kenya.

1.0 INTRODUCTION

The handicrafts industry is an important source of livelihood for many people in Africa, especially the rural poor. In Kenya, wood-carving is the most important component of the handicrafts industry. Like other handicrafts activities, wood carving makes use of locally available natural resources and requires traditional skills and minimal capital input. Often classified as a small scale cottage industry, wood carving not only provides self-employment to many people, but also supplements household incomes from subsistence agriculture. In certain sections of Kenya's communities, for example, the Akamba of Wamunyu village in Machakos District, wood carving is the major source of household earnings, with over 80% of the villagers engaged in the industry. Overall, the wood carving industry supports, directly and indirectly, some 3(X),(XX) people in Kenya, and earned the country over Ksh. 100 million in exports alone, in 1994. (Obunga,1995)

Like most of other handicraft activities, woodcarving industry evolved from material culture and is still widely so practised by many rural communities in Kenya. The basic resource on which the industry relies is the indigenous raw materials in the form of hardwoods. As a material culture activity, wood carving ensured that a sustainable balance existed between the resource base and the socio-cultural needs. Commercialisation of material culture products derived from a naturally renewable resource is likely to cause long-term detrimental impacts on the ecosystem unless the industry's resource base is developed at a pace corresponding to the demand rate. In the arid and semi-arid areas (ASALS) of Kenya, also the cradle of woodcarving industry, record of long history of environmental degradation implies that the resultant unfavourable ecological conditions not only limit the rate of plant growth, but the biomass produced is invariably poor and inadequate for sustainable commercial exploitation. Thus, when commercialisation of wood carving started among the Akamba of Machakos soon after the World War I, it became inevitable that without any coupling resource conservation efforts, the problem of finding extraction rates that are ecologically sustainable and profitable would arise.

Over the past couple of decades the drastic and steady increase in the demand for the wood carving raw materials has had marked effects on the natural populations of the most preferred hardwood species. In most of the areas close to the wood carving centres and communities, local resources have been depleted. Since the demand for wood carving has continued to rise, and the trend is forecasted to increase in the future, the carvers have responded to the scarcity by resorting to:

- substitution of new tree species, both indigenous and exotics, as alternatives, the latter often possessing similar characteristics to the traditional carving hard woods;
- importation of the raw materials from elsewhere; and
- migration to new areas in search of the traditionally favoured species.

In either case, the overall effect has been the increased costs and the intensified depletion of local sources of raw materials.

The problem of exploitation and the resultant scarcity of the indigenous species used for carving is closely linked to the multiple demands on the hardwoods as carvers must compete for the same species with other users seeking fuel wood, fencing and building materials, and also for a variety of many other wood-based industries. In addition, due to human population pressure, encroachment and clearance of indigenous forests is taking place to pave way for settlements, urban related development projects and cultivation. In some areas, local extinctions of some of the most preferred species have occurred as a result of over-harvesting. To the wood-carving community and the relatively large number of other people whose lives revolve around the carving industry, these combined adverse impacts on the indigenous raw materials pose a real threat to their major source of livelihood.

Despite the significant role the industry contributes to the Kenyan economy, there is limited data on its dynamics. In order to ensure the sustainability of the industry, there is urgent need to collect and publicise accurate information on its dynamics. Such information can then be used to initiate activities towards natural resource conservation and management, regulation, research and propagation as ultimate means of securing sustainability for the industry.

This report is the second in the series of this two year People and Plants Initiative Project of the WWF, UNESCO and the Royal Botanic Gardens, Kew (UK). The first phase (June - DEC 1995) covered the socio-economic aspects of the industry. The current Phase II of the project focusing on resource inventory and impact assessment has its foundation on the baseline date obtained during the initial phase, and which covered a wide spectrum of the resource users who are often best placed to provide detailed information about their resources.

Resource inventory exercise in the current phase is important because it is focussed to provide information on the natural distribution, abundance, population structure (density, age/size distribution, number of productive adults), and population dynamics (mortality, recruitment, growth and reproductive rates). Data collected is aimed at providing sufficient information useful in assessing sustainability by direct comparison between natural and harvested populations (e.g. the data collected in Phase I revealed the number of people involved in carving, preferential species demand, volumes of timber supplied by species to woodcarvers, and the volumes traded may be compared with the remaining volumes in the known resource areas, in order to determine sustainability).

The present study focuses on the following five species in their ranked order of preferences: 1. *Dalbergia melanoxylon* (Ebony/Mpingo); 2. *Brachylaena huillensis* (Mahogany/Muhuhu); 3. *Olea africana* (Olive/Mutamaiyu); 4. *Combretum schumanii* (Teak/Mwa-osi); 5. *Terminalia spinosa* (Teak/Mutanga). These species constitute the largest volumes of all the timber identified as used for carving in the industry. The source areas were identified in the following three geographical regions in Kenya:

- the lowland dry forests at the Coast (Shimba Hills Forest, Arabuko Sokoke Forest Reserve etc.)
- the woodlands and forests in Eastern Province, (Chyulu Hills, Wamunyu etc.); and
- the upland dry (semi-deciduous) forests in Central Kenya, comprising Karura, Ngong and Ololua, all near Nairobi.

This particular study is part of an extensive resource inventory exercise and aims at examining the natural population structure and dynamics, as well as the extent of human impact on *Brachylaena huillensis*, the main timber species for carving, obtained from the above mentioned three central Kenya forests.

2.0 STUDY AREAS

The study was conducted between April and June in Karura, Ngong and Ololua (Ngong Hills) forests. The first two sites lie about the intersection of Latitude 1.5° S and Longitude 37° E and are approximately 10 km apart. Ngong Road forest is at 1860m a.s.l. while Karura is at 1750m a.s.l. (Fig. 1). The Ololua Forest is situated to the South West of Nairobi at 01° 22'S, 36° 42'E, and lies at an altitude of between 1750 - 1850m a.s.l. The latter forest provided a unique site and opportunity for comparative study. The forest has an exclusion area (Nature Reserve) managed by the National Museums of Kenya as an Institute of Primate Research (IPR). The demarcated area of the National Museums of Kenya is about 125 ha., while the total area of the Ololua forest has been given as 325 ha. by Doute, *et al*, (1976) (Fig. 2).

The three forests have bimodal rainfall patterns and receive their peak rainfall in April and May, followed by a short rainy season between October and December. The mean annual temperatures for Ngong Road and Karura Forests range between 24° C and 11° C for mean annual maximum and minimum, respectively. A maximum of 33° C has been recorded at Karura. The mean temperatures for Ololua is 17.5° C. The vegetation of the three areas can be characterised as dry upland forest and are similar in composition to the *Brachylaena - Croton* forest of Lind Morrison (1974); while Trapnell and Brunt (1987) mapped Ololua as dry intermediate (undifferentiated) forest. Additional information on the climatic conditions, geology, soils and species composition of the forests is given by Kigomo, *et al* (1990) and Trump (1987).

3.0 METHODS

3.1 Sampling Intensity

Kigomo *et al* (1991) reported that *Brachylaena huillensis* is distributed in patches both in Ngong Road and Karura forests. During a reconnaissance survey of Ololua forest, it was confirmed that discrete pattern of distribution is a common feature of the species in the above upland semi-deciduous forests. In order to develop an efficient and cost-effective way of sampling *B. huillensis* in the three forests, it was necessary to determine the number of plots (sample size) in each of the forests. Sampling intensity is an essential criterion to estimate, and depends on the required precision of the estimates. It is conventional to try to achieve confidence limits of 10% at the 95% probability level or the mean of 5% (Blackett, 1994) The statistical objective was therefore defined as achieving a standard error equal to 5% of the mean basal area of trees greater than 10 cm diameter at breast height (dbh).

Initial sampling for determining sample size was done on a few pilot plots selected randomly in each of the forests' blocks with *B. huillensis*. Table 1 and 2 show the statistical formula used in calculating the number of plots required and the sampling intensities of the different forests.

Sampling of *Brachylaena huillensis* was done in 20 x 20 m (0.04 ha.) plots which were randomly located in selected natural forest blocks with representative stands of this species. Choice of quantitative and qualitative data in each forest was based on two objectives: one, to assess the current population status and the various forms and intensities of human impact on the *B. huillensis* by observing and measuring a variety of parameters of all the individual standing (live) or felled trees; and two, to measure and record the regeneration potential of the species through seedling establishment and coppicing.

In each plot the following parameters were measured and recorded for *B. huillensis:*

- basal diameter (bd) and diameter at breast height (dbh) of all standing live or standing dead individuals;
- basal diameters of all stumps of cut (felled) individuals. For each stump, height of cut, measured from the base, and the methods of exploitation (panga, axe, power saw) were recorded. As an additional indicator of frequency and intensity of utilization, attempt was made to determine the age of cut (stumps) on the basis of some observed conditions e.g. degree of freshness or dryness, evidence of rotting, appearance/condition of post-harvest tree parts (leaves, twigs, branches) and then classified into the following 3 cut age of cut categories: < 3 months, 3 months - 1 year, or rotten.
- stem diameters of seedlings and coppices measured using callipers with 0.01 precision were enumerated and each individual sorted out into one of the four size categories: 0 - 0.5 cm, 0.5 - 1.0 cm, 1.0 - 2.0 cm, > 2.0 cm. Coppices were classified as separate individuals, but a record kept reflected the total number from each tree or stump.

In each plot note was taken of the general appearance of the forest with regard to dominant vegetation and associates; type of gaps; slope and aspect; signs of herbivory disturbance on seedlings/coppices; die-backs; parasitism; and other evidences of disturbances (footpaths and logging paths, animal burrows, invasives, open canopies, etc.).

Table 1: **Summary of statistical formula used in determining sampling intensity**

DESCRIPTION	**FORMULA**
The arithmetic mean and Basal area observations	$\bar{X} = \frac{\sum x}{n}$
Sample standard deviation	$\sqrt{\frac{\sum x^2 - (\sum x)^2/n}{n-1}} = s$
Co-efficient of Variation	$CV = \frac{S}{\bar{X}}$
Plots required (Philip,1983)	$N = CV^2/P^2$ N= The required no of plots requred,CV is co-efficient of variation, P is the acceptable precision limit (10%, p= 0.10)

Table2: **Summary of sampling intensities required for the different forest blocks**

FOREST BLOCK	**SAMPLE SIZE**
KARURA	40
NGONG ROAD	50
OLOLUA	20
IPR*	18

*Institute of Primate Research

4.0 RESULTS

4.1 Population structure and regeneration:

4.1.1 Karura Forest:

Figure 3(a) shows the diameter size class distribution profiles of *Brachylaena huillensis* in Karura forest. Although the histogram shows that the distribution conforms to a normal, inverse J-shaped curve in which there is a progressive decline in the numbers in the size classes from the small individuals to the mature trees, there is however only adequate representation of the small and intermediate size classes (5 - 7 cm diameters). The large (mature) size classes over 40 cm dbh are very poorly represented in the population. Figure 3(b) illustrates the basal diameters (bd) of cut stumps of *B. huillensis* sampled in Karura. There was selective exploitation of various size classes with the greatest human impact on the mature (commercial) sizes > 40 cm. These sizes have mainly been logged for industrial purposes, including the carving industry. The predominant method of harvesting was by power saw (Table 3), with most of the trees cut at 34 cm above the ground (Fig 3(c)).

In terms of recruitment, Karura forest had a high potential with very high density of seedlings in the 0 - 0.5 cm size category, and an almost equal number in the sapling categories (1 - 2.0 cm). (Table 4)

4.1.2 Ngong Road Forests

Ngong forest is divided into various distinct blocks among which the following were sampled:- Kibera block, which encompasses the Racecourse, Rowallan Scouts Camp and the Dog Pound area, all bordered By the Kibera slums, and the Langata/Karen block which is bordered by the Bomas of Kenya, and the Old Forest Guard's Post and House.

[redacted]

Fig 3(a) : DBH Size-Class distribution for Karura Natural Forest

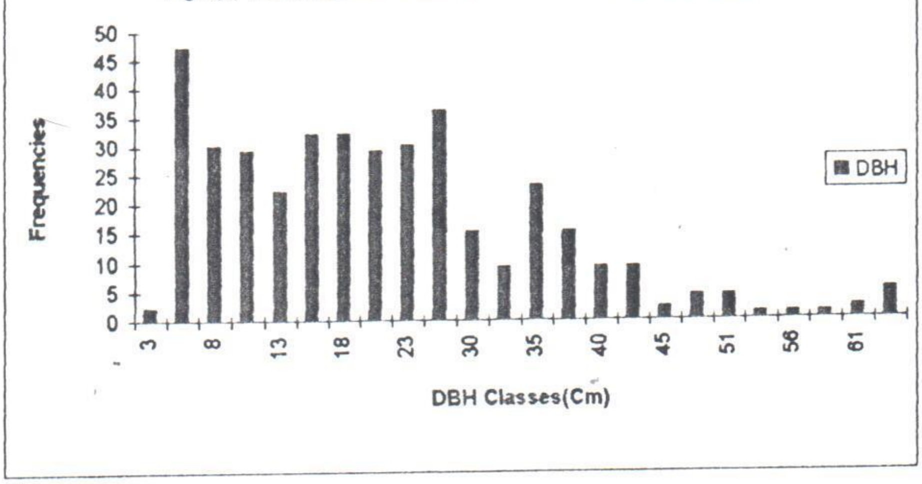


Fig 3(b) : BD Size-Class Distribution of cut treesin Karura Natural Forest

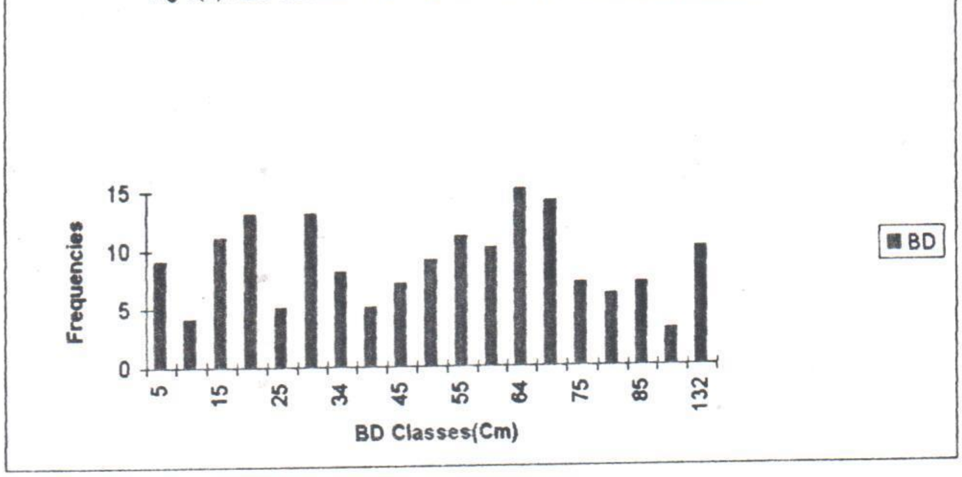


Fig 3(c) : The distribution of height of cut in Karura Natural Forest

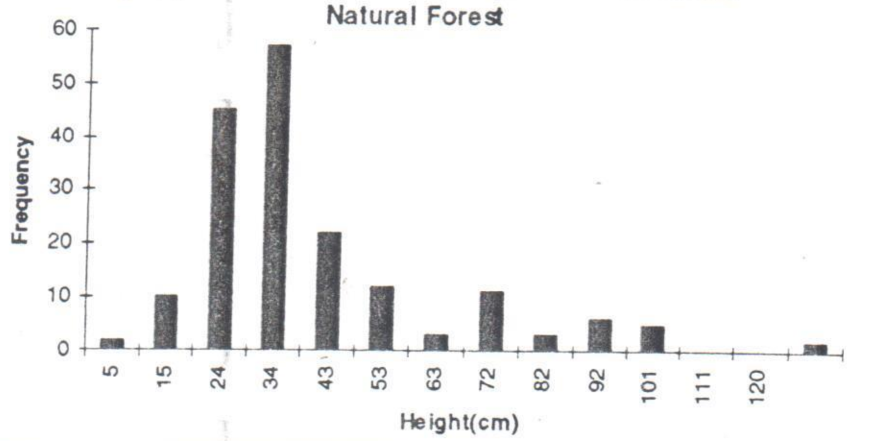


Table 3: Summary of cutting methods used in different forest blocks

Method of Cutting (Frequencies)				
BLOCK	Axe	Power Saw	Panga	Unknown
Karura	13	143	18	3
Karen	8	8	21	10
Kibera	30	2	17	1
Ololua	3	3	15	11
IPR	0	1	20	9

Table 4: The regenerations recorded in number of stems per diameter class

Diameter Class (Cm)			
Forest Block	0-0.5	0.5-1.0	1.0-2.0
Karura	1750	162	192
IPR	82	89	79
Ololua	76	98	103
Kibera	1020	402	291
Karen	964	585	137

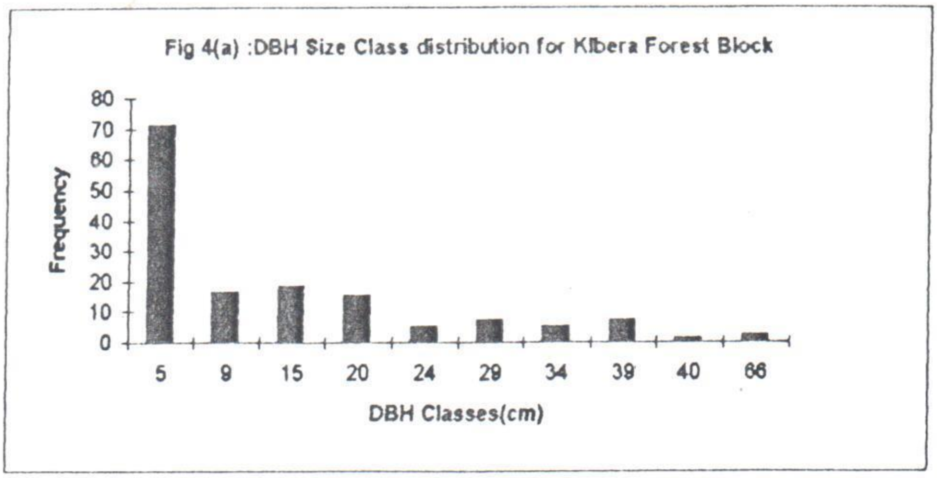


Fig 4(a) :DBH Size Class distribution for Kibera Forest Block
Frequency
80
70
60
50
40
30
20
10
0
5
9
15
20
24
29
34
39
40
66
DBH Classes(cm)

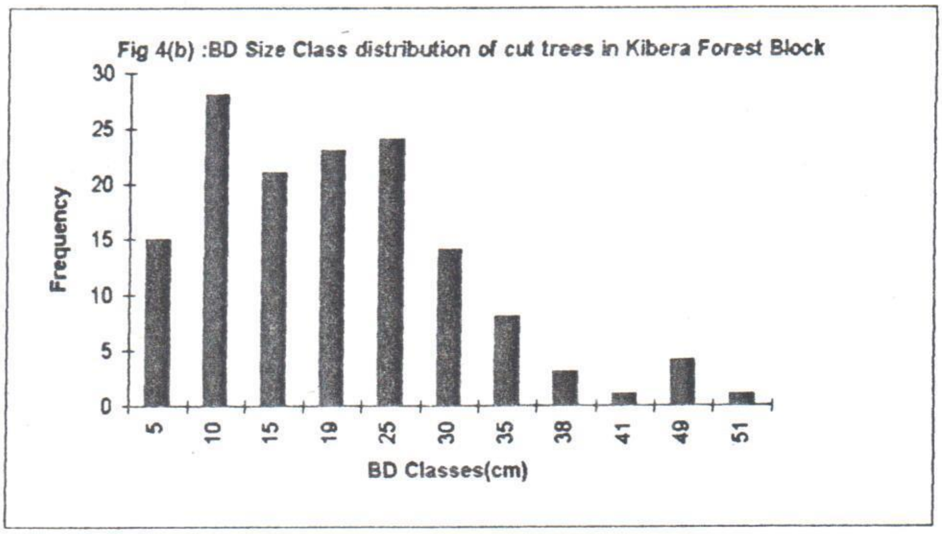
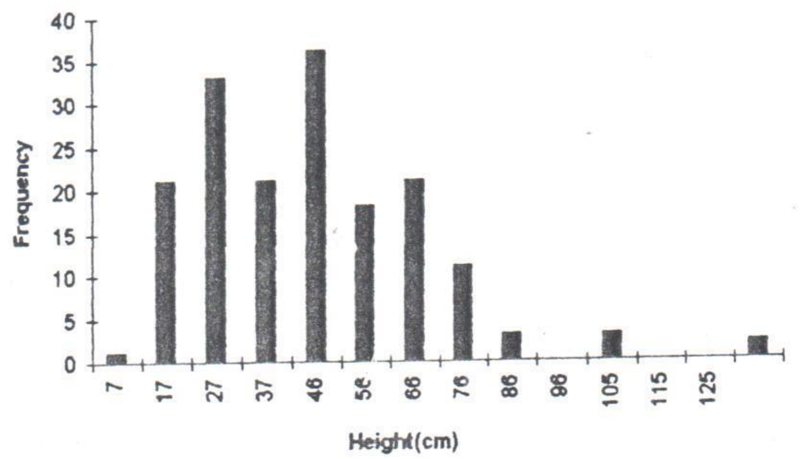


Fig 4(b) :BD Size Class distribution of cut trees in Kibera Forest Block
Frequency
30
25
20
15
10
5
0
5
10
15
19
25
30
35
38
41
49
51
BD Classes(cm)

Fig 4(c):The distribution of height of cut in Kibera Forest Block



4.1.2.1 Kibera Block

The diameter at breast height (dbh) as an indication of population size/age structure of *B. huillensis* shows a poor distribution with only a fair representation in the small diameter individuals < 5 cm. (Table 4) Figure 4(c) shows the basal diameter class distribution of cut individuals in the Kibera block. Although exploitation is taking place on all size classes, there is indication of most intense impact on the medium sizes in the 10 - 25 cm basal diameter range. The predominant methods of harvesting these size class range were by axe and panga (machette) (Table 3).

Regeneration potential for *B. huillensis* in Kibera block was adequately represented with over 1000 seedlings with a fair distribution of seedlings in the 0.5 - 2.0 cm size classes (Table 4).

4.1.2.2 Langata (Karen) Block

Figure 5(a) shows that the diameter size class distribution of *B. huillensis* in Langata block is characterised by 'peaks' and 'valleys' signifying a population whose regeneration has suffered interruptions in seedling establishment. Like its neighbouring block Kibera, the Langata-Karen forest block is also under intensive human pressure as illustrated in the basal diameter size classes of the harvested individuals. (Fig. 5(c)). The block had also a fairly high potential of regeneration with good representation in the 0.5 - 1.0 cm stem diameters. There was however poor representation in the seedlings sizes > 1.0 cm. (Table 4).

4.1.3 Ololua Forest

The diameter size class distribution profiles of *B. huillensis* in Ololua was characterised by poor representation in the smaller individuals (2 - 7 cm diameters) and a skewed distribution in the larger size classes (between 30 - 45 cm. dbh) (Fig. 6(a)). There was absence of mature individuals of more than 50 cm (dbh). The only size classes with fair representation were intermediate size ranges between 10. - 15 cm (dbh), with a progressive decline towards the medium size classes. Basal diameter of harvested individuals shows that impact is heavy on all size classes with preferential demand on the replacement (7 cm), the intermediate and medium classes (20 - 25 cm); all these size/class categories had been harvested mainly by panga (Table 3 and Fig. 6(b)). Ololua had poor regeneration potential with very low density of seedlings and very few saplings. (Table 4).

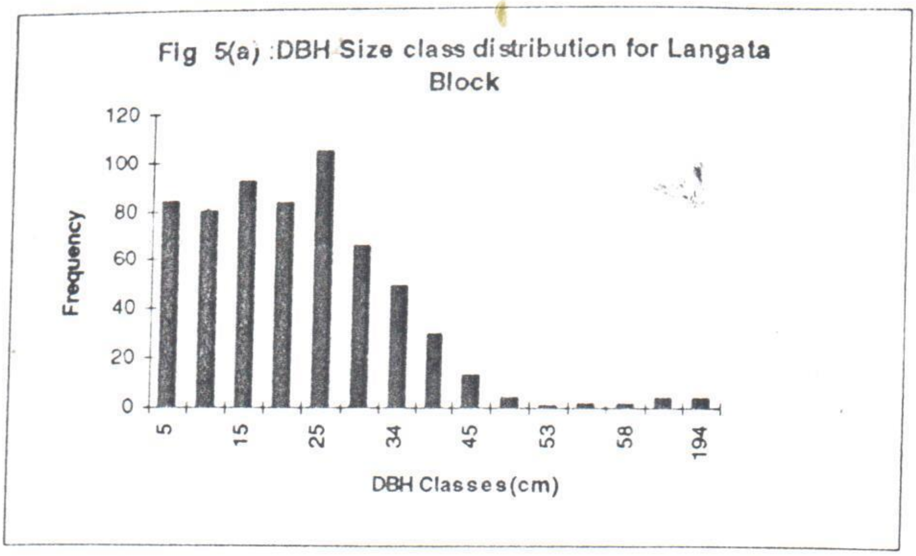


Fig 5(a) :DBH Size class distribution for Langata Block
Frequency
120
100
80
60
40
20
0
5
15
25
34
45
53
58
194
DBH Classes(cm)

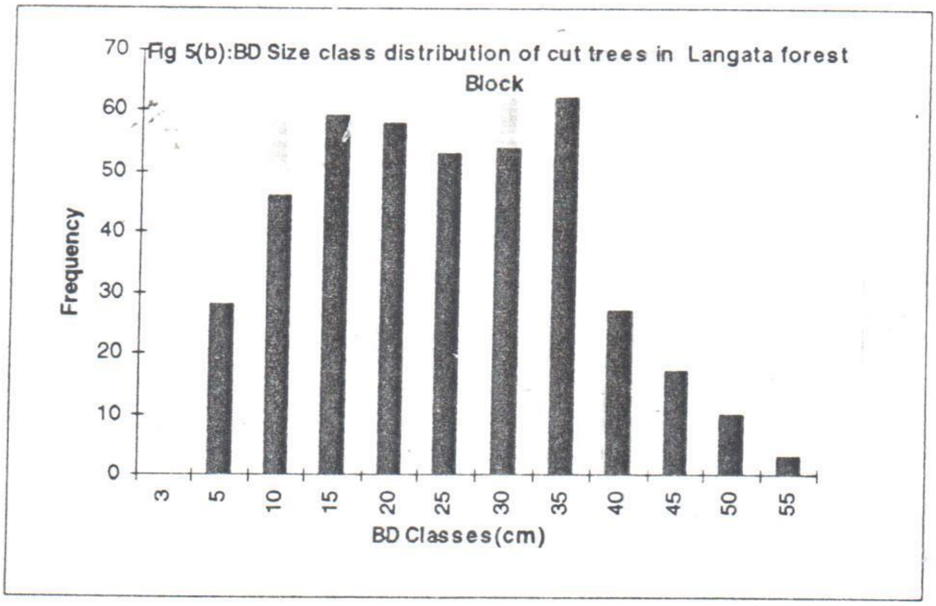


Fig 5(b):BD Size class distribution of cut trees in Langata forest Block
Frequency
70
60
50
40
30
20
10
0
3
5
10
15
20
25
30
35
40
45
50
55
BD Classes(cm)

Fig 5(c) : The Distribution of height of cut for Langata Forest Block

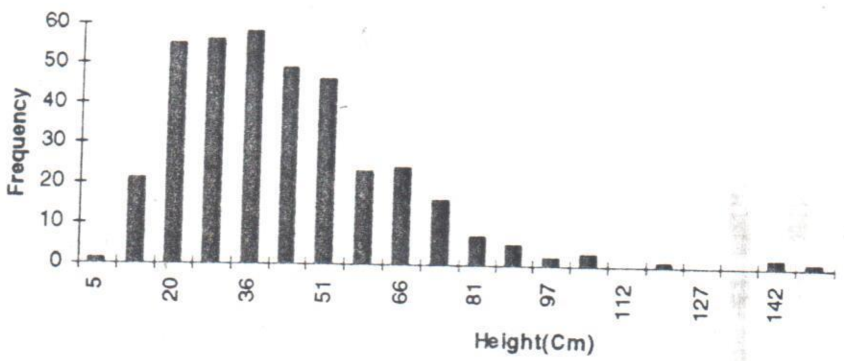


Fig 6(a): DBH Size class distribution for Ololua Forest Block

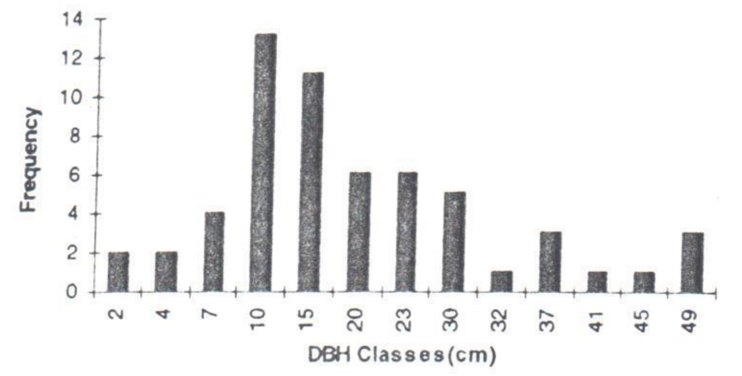
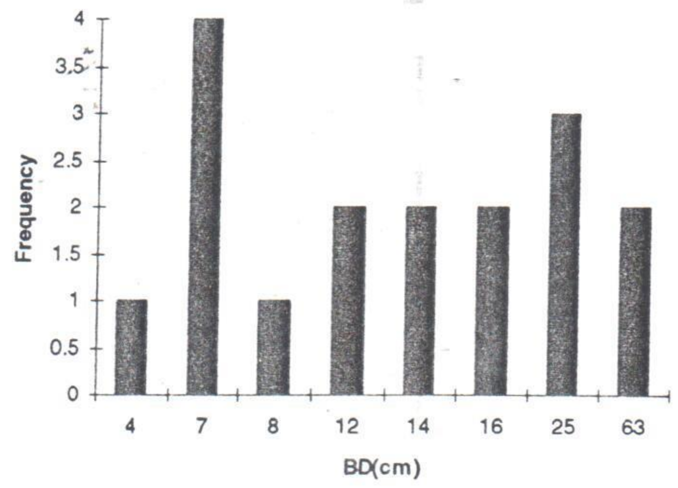


Fig 6(b): BD Size class distribution of cut trees in Ololua Forest Block



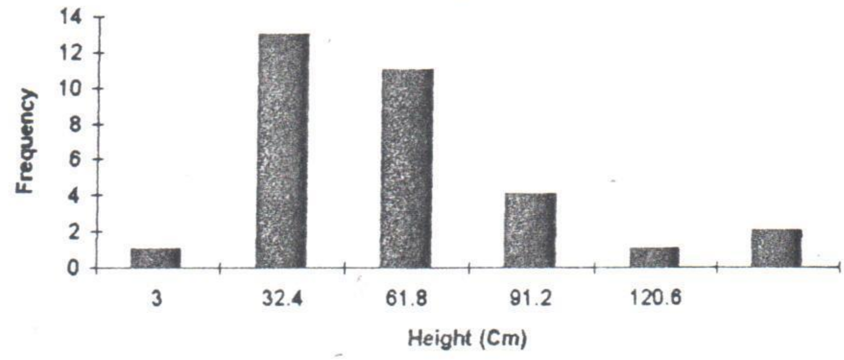


Fig 6(c) : The distribution of height of cut for Ololua forest

Fig 7(a): DBH Size class distribution for IPR Nature reserve

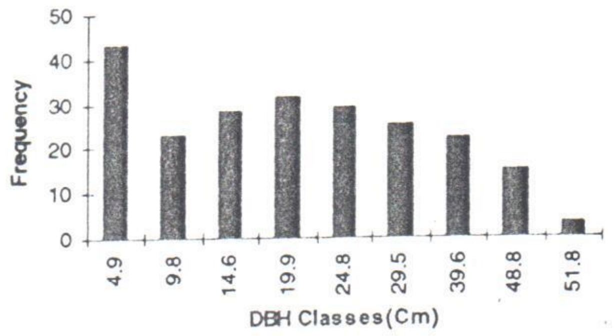


Fig 7(b): BD Size class distribution for IPR Nature reserve

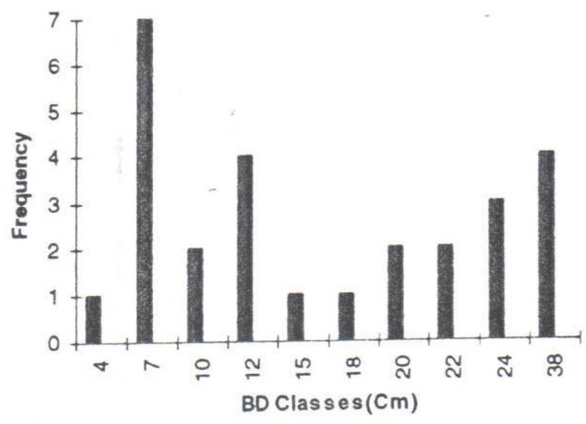
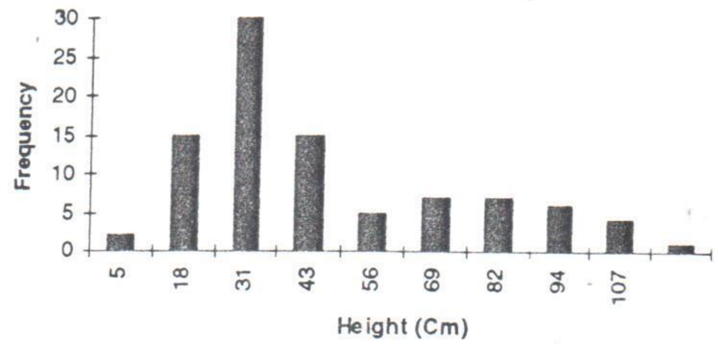


Fig 7(c) : The distribution of height of cut for IPR Nature Reserve



4.1.4 IPR (Institute of Primate Research) / Nature Reserve

This is part of the larger Ololua forest and lies adjacent to it. It is an exclusion zone, and has had total protection as a Nature Reserve since 1987.

Figure 7 (a) shows that diameter class distribution of *B. huillensis* in the forest is well represented in the small size-class category (5 cm diameters). There is however decline in the number of mature individuals > 40 cm (dbh).

Selective harvesting of smaller, replacement individuals (7 - 12 cm) and also the intermediate classes (> 20 cm bd) had occurred in the reserve Fig. 7(b). It was also observed that the fellings were fairly recent and were mainly made to clear the motor paths for the Institute's vehicles. Predominant method of felling was by panga (Table 3). There was evidence of flush regeneration occurring in all three size class categories (0.5 - 2.0 cm) (Table 4). This may be attributed to the protection the forest has been accorded since 1987.

5.0 DISCUSSION AND CONCLUSION

Indigenous trees fulfil many household needs by providing sources of food, medicines, fuelwood, building and construction materials; they also support a variety of wood-based industries.

In the upland dry, (semi-deciduous) forests in Central Kenya and elsewhere in East Africa, *Brachylaena huillensis* is the most important commercial tree (UNESCO 1973). The tree belongs to the family Compositae (= Asterceae), and it is the only wood species in the family to develop to timber size (Lind and Morrison, 1974). It is also dioecious (Beentje, 1994; Kigomo, 1990). The three upland forests (Karura, Ngong and Ololua) are located in areas which have experienced some of the most rapid human population growths in recent times, as Nairobi City and its environs continue to attract large immigrants from the rural areas searching for livelihood opportunities. These factors have caused considerable disturbance to the forests.

Impact assessment of the three forests indicated that *B. huillensis* is the most exploited hardwood in the forests. Past and current preferential demands on the various size classes have had significant effect on the species. In Karura, the diameter size class distribution profiles showed a fair representation in the smaller diameter classes however, the larger diameter size-classes > 50 were very poorly represented in the *B. huillensis* population. It was observed that most of the larger diameter individuals remaining in the forest were either deformed excessively fluted or had been attacked by the parasitic *Ficus thonningii*. Direct observation corroborated by data obtained from the Forest Department as well as anecdotal information from elder woodcarvers from Wamunyu and Nairobi co-operatives confirmed that Karura has been under pressure of selective felling for a long time; it had also the best stands of the largest diameter individuals as illustrated in Figure 4 (b). These classes formed the basis of wood-based industries in Nairobi and beyond, and this included woodcarving.

Currently the remaining small and medium size categories are being harvested to meet the household needs by the large populations around the forest. It was claimed by the forest officials that most of the settlements on the fringe of the forest were illegal, and the residents themselves besides exploiting *B. huillensis* for the fuel wood and building requirements, they were also involved in illegal logging for sale to timber merchants.

The Ngong Road forest comprises Kibera and Karen-Langata blocks which possess representative stands of *B. huillensis*. It is important to note that this forest is closest to the City Centre and is bordered on one side by one of the largest and heavily populated urban slums in Kenya, and by far the largest in Nairobi. Like other slums elsewhere, Kibera is characterised by large populations within the low-income bracket, majority of whom depend entirely on wood as their predominant energy source as well as for building. Secondly, the majority of houses within the slums are semi-permanent structures which require different diameter size classes for the ground foundation, laths (withies) and rafters which are then reinforced with mud, iron sheets or cardboard. Since the population in the slums is ever increasing, so does the demand for polewood for building the structures. It is important to note that these dwellings have to be constantly repaired, the frequency depending on weather conditions. Besides construction of the dwellings, polewoods mainly of *B. huillensis* is used for building the numerous roadside structures *(bandas)* in the area and used as sheds for selling fruits, vegetables and cigarettes. Firewood collection has a different dimensions in the Kibera blocks. Essentially, firewood collectors normally obtain temporary permits for collecting only dead wood, but in Kibera it was observed that the entire forest is devoid of any dead wood. As a result, it was observed that people were still obtaining the permits, but since there was no dead wood, they had reverted to direct cutting of live trees, excessive lopping of branches and stems, and bark ringing and debarking in order to enhance mortality. This was done with impunity, since they claimed they had the official document.

In addition, it was observed that there is tendency to over-exploit as the harvesters could visit the forests a couple of times a day. It was found out later that most harvesters obtained wood for two purposes; one, for direct use, and secondly, for sale in the fuelwood markets in the slum. Much of the fuelwood was also destined for the numerous illicit *Changaa* breweries along the river dividing the forest from the slums. Impact on Kibera forest is not confined to the "residents" slum dwellers alone; during the survey 3 different groups consisting of 19 women with kilo-loads of firewood were spotted heading in the opposite direction from Kibera. It was later learnt from a forest guard that they were regulars and came from the Riruta-Dagoretti area, some three kilometres away.

Because of the preferential demand on *B. huillensis*, it was observed that the harvesters were actually mining the resource by harvesting the stumps. The consequences of this practice are two-fold: one, stumps are potential trees, and by so mining they were causing damage to potential sources of coppices; two, stumps of *B. huillensis* are considered as potential carving materials as in areas where the carving resources had been depleted e.g. Kwa Vonza in Yatta Plateau near Wamunyu, carvers were seen going back into the woodlands to dig out the stumps of *Brachylaena huillensis* for use in carving. Similar practice was also observed with *Dalbergia melanoxylon* whose extensive roots are used for carving the popular letter openers and the "stick-men".

Disturbance and impact on the *B. huillensis* by livestock was observed mainly in Ngong Hills/Ololua and the Ngong Road forests. Disturbance was minimal in Karura. In the former sites we observed that livestock were grazing right inside the forests, although small antelopes were also observed. It became evident, however, that the domestic herbivores had the greatest impact on the *B. huillensis* through trampling and browsing on the juvenile plants. Although grazing livestock in the above sites is not unusual, because the Masaai are known to use the areas as dry season grazing refuge when there is drought in the plains, it then appeared that livestock movement in the forest is not adequately controlled. Further, in attempt to assess the general health of the forest, a subjective assessment of disturbance for each forest was determined based on observed frequency or levels of these disturbance indicators; browsing/grazing; logging/trampling tracks; footpaths; lopping; invasives/aliens; animal burrows; gaps/open canopies. All the forests, except the IPR/Natural Reserve where shown to be threatened by all the above observed disturbances, with Ngong Hills (Ololua), Kibera block of Ngong Road Forest in that decreasing order. The numerous gaps in the forests were observed being invaded by the noxious *Lantana sp.* which formed extensive under-storeys and were observed hindering the regeneration of *B. huillensis*. The gaps in turn were indicators of clear felling in the forests.

The study shows that the greatest impacts on the three Nairobi areas forests are emanating from human populations living near the forests as evidenced by their very high dependence on the forest resources for their daily needs. The problem of over-exploitation is projected to intensify and is further exacerbated by these factors:

- the recently liberalised economy means that the co-operative control is no longer tenable as more people are individually seeking and opening new markets for woodcarving abroad, as shown in export data in Phase I report. As a cottage industry it draws and will continue to attract a lot of jobless people, majority of whom are school leavers armed with less skills and marginal capital outlay for starting the business. Further, the rapidly rising population with the trend towards settling in forested areas implies that settling populations will consequently compete for the land and convert it to other uses leading to a decline in the total area of natural vegetation as a source of supply of carving species. The practice was observed to be rampant in several blocks of Ngong, Ololua and Karura forests where large areas of *Brachylaena* and *Croton* have been cleared for cultivation and residential expansion, with more plots earmarked for similar purposes.

- Kigomo (1994) in his study on rates of growth of *B. huillensis* in the 3 forests estimated that without intensive management inputs, the rotation period for the species is very slow under natural conditions with individuals reaching merchantable diameter sizes of 40 cm and 45 cm dbh after 100 and 130 years, respectively. From the foregoing, it is clear that at the current demand rate, the supply of *B. huillensis* in all the 3 forests is not sustainable. The problem of impending crisis caused by scarcity has long been realised by the resource users (carvers) who have in turn began experimenting with alternative species with some similar characteristics to these traditional ones. For example, the last couple of years the carvers have successfully adopted *Azadirachta indica* (Neem) as an alternative to *B. huillensis*, and is being marketed under the trade name, Mahogany. Besides the desirable physical attributes of the wood, it is relatively abundant along the coast, and has a shorter rotation period (15 - 20 years).

The observation that majority of relatively smaller (20 - 30 cm) diameter class of *B. huillensis* are reaching the co-operatives during the last survey confirms the fear that commercial incentives and selective demand for *B. huillensis* imply that despite the scarcity, heavy harvesting will continue as people are ready to take risks for the attractive prices the species fetch. Thus while *B. huillensis* remains valuable hardwood species for carving, its sustainability can still be managed through effective control of further harvesting in areas where its population is threatened for both the short-term and long-term. Experimentation with alternative species as well as diversification into the use of non-wood raw materials for handicrafts can be some of the conservation measures to be used to achieve sustainability.

ACKNOWLEDGEMENTS

The authors are thankful to the following organizations and individuals who were instrumental in making the reporting period successful: WWF and UNESCO for continued provision of the implementation funds; Dr. Tony Cunningham (People and Plants Initiative) and Dr. Nina Marshall (IUCN/Traffic) for assisting in the launching the phase II of the project which entailed spending long hours in the field developing methodology for conducting the field work; KEFRI representatives, Mr. Jackson Mulatya, Simon Choge and Augustine Wandabwa who assisted at various stages of the initial field work. Finally we are grateful for the co-operation received from all the collaborating institutions including invaluable assistance from Mr. Caleb Orwa (Database Liaison Officer) and Mr. Namachanja Pius (GIS Officer) both of Biodiversity Database Centre, NMK.

REFERENCES

Beentje, H&J. 1994. Kenya Trees and Shrubs and Lianas. National Museums of Kenya, Nairobi: Kenya.

Blacket, H.L. 1994. Forest Inventory Report No. 3, Kakamega. KIFCON.

Doute, R.; Ochanda, N. & Epp. H. 1981. Forest Cover mapping in Kenya using remote sensing techniques. KREMU Technical Report.

Kigomo, B.N.; P.S. Savill and S.R. Woodel. 1990. Forest composition and its regeneration dynamics: a case study of semi-deciduous tropical forests in Kenya. *African Journal of ecology, Vol. 28, pp. 174-188.*

Lind, E.M. & Morrison, M.E.S. 1974. East African Vegetation. Longman. London.

Morgan, M.T.W. 1967. Nairobi City in the Region. Oxford University Press, Nairobi.

Obunga, R. 1995. Sustainable development of Woodcarving Industry in Kenya, Phase I Technical Progress Report

Trapnell, C.G. & Brunt, M.A. 1987. Vegetation and Climatic maps of South Western Kenya. LRDC/ODA, Surbiton.

UNESCO. 1973. International classification and mapping of vegetation. Ecology and Conservation. Series No. 16. UNESCO.