Quantification of monetary losses due to illegal pitsawing in Budongo Forest, Uganda

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SUMMARY

The paper examines the financial implications of both abandoned and destroyed wood by illegal pitsawers in Budongo Forest, Uganda. It also compares the intensity of pitsawing in the Strict Nature Reserve (SNR) and the forest edge as well as the species and diameter classes of trees most affected. The total wastage of round wood was found to be 0.218 m3/ha/yr and 0.098 m3/ha/yr in the SNR and forest edge respectively. This is about a third of the mean annual increment per hectare per year for tropical moist forests. The present value of monetary losses in the SNR and forest edge were UGX 30 000 /ha/yr and UGX 17 814/ha/year respectively; with Mahogany species as the most affected. There was no significant loss of wood between the SNR and the forest edge and no significant diameter variations in the illegally pitsawn trees within and between the different pitsawing sites. More trees were pitsawn at the forest edge as compared to the SNR, although a larger volume of wood was harvested in the SNR. There is a need to enforce effective forest regulations governing SNRs; and foster a functional working relationship between the National Forestry Authority and local communities around the forest in the management of the SNR.

Keywords: illegal logging, monetary value, illegal extraction, wood volume

Quantification des pertes monétaires causées par la coupe du bois illégale dans la forêt de Budongo en Uganda.

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Cet article examine les implications financières du bois abandonné et du bois détruit par les scieurs de bois illégaux dans la forêt de Budongo en Uganda. Il compare également l'intensité de la coupe de bois dans la réserve naturelle stricte (SNR) et à l'orée de la forêt, ainsi que les espèces et les classes de diamètre des arbres les plus affectés. Le gâchis total de bois rond s'est trouvé être de 0.218 m3/ha/an et de 0.098 m3/ha/an dans la SNR et l'orée de la forêt respectivement. Cela constitue à peu près un tiers de la croissance moyenne annuelle par hectare pour les forêts humides tropicales. La valeur actuelle des pertes monétaires dans le SNJ et l'orée de la forêt atteignait respectivement UGX 30 000/ha/an et UGX 17 814/ha/an, les espèces d'acajou étant les plus affectées. Il n'y avait pas de perte importante de bois entre la SNR et l'orée, et pas de variations de diamètre importantes dans les bois coupés illégalement à l'intérieur des sites, et entre eux. Il y avait davantage d'arbres coupés au bord de la forêt que dans la SNR, bien qu'un plus gros volume de bois ait été récolté dans la SNR. Il est nécessaire de pouvoir mettre en force les règles forestières efficaces qui gouvernent les SNRs, et de développer une relation de travail fonctionnelle entre l'Autorité Nationale de Forêts et les communautés locales autour de forêts gérées par la SNR.

Cuantificación de pérdidas monetarias causadas por el aserrado manual ilegal en el bosque de Budongo, Uganda

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Este estudio examina las implicaciones financieras de madera abandonada y destruída por el aserrado manual en foso ilegal en el bosque de Budongo, Uganda. Se compara también el grado de intensidad del aserrado manual en foso en la Reserva Natural Integral (SNR) y en los límites del bosque, además de las especies y categorías de diámetro de los árboles más afectados. Se descubrió que la pérdida total de madera redonda fue de un 0.218 metros cuadrados por hectárea anual en la SNR y 0.098 m en los límites del bosque. Estas cifras son equivalentes a una tercera parte del incremento anual promedio en los bosques tropicales húmedos. El valor actual de pérdidas monetarias en la SNR y en los límites del bosque son de 30 000 y 17 814 chelines ugandeses anuales por hectárea respectivamente, y las especies más afectadas fueron las caobas. No hubo pérdida importante de madera entre la SNR y los límites del bosque, y no se registraron variaciones significativas de diámetro entre los árboles talados ilegalmente dentro ni entre los diferentes lugares donde se practicó el aserrado manual en foso. Se taló un mayor número de árboles en los límites del bosque en comparación con la SNR, aunque en la SNR se cosechó mayor volumen de madera. Resulta necesario hacer cumplir reglamentos forestales eficaces en las SNR, y promover una relación de trabajo funcional entre las autoridades forestales nacionales y las comunidades locales, en aras de mejorar la gestión del bosque.

INTRODUCTION

According to the National Environmental Plan for Uganda, 1996, pitsawing started in Uganda in the early 1930s but was abandoned in the 1960s with the introduction of machine milling technologies. However, during the period of political turmoil, pitsawing took a new economic life and it is now believed that there are hundreds of pitsawyers operating in Uganda's high tropical rain forests. In 1991, Uganda used 1 000 000m^3 of industrial round wood, 95% of which came from hard wood forests. Of this figure, 96% was cut by pitsawyers (Forest Department 1993). The 1993 Forest Department report indicated that pitsawing had played an important role in the deforestation of many forests including Budongo Forest Reserve (BFR); something that had been evident for a number of years (Plumptre 2004).

Pitsawing is a simple (cash and technology) process of converting round wood (logs) into sawn timber using a pit stand, a two-man saw and two men (Ruyooka 1985). Pitsawing in BFR involves selective felling of trees followed by hand sawing of logs into boards using a two-man cross cut saw (rip saw) resulting in reasonable yields of quality boards (Kijoti and White 1981, Solberg1988, Skage and Naess 1994). In addition to causing forest degradation, it encourages forest crime, corruption and tax evasion (Legal status of sawmills 2000). According to the Budongo forest management plan of 1997-2007, many timber traders especially from Masindi town are involved in illegal timber production. They hire pitsawyers and finance all the pitsawing operations. Pitsawing artisans (*fundis*) are both migrant workers and the local people from the vicinity of BF who carry out most of the activities at night or in areas very deep into the forest that are not easily reached by a forest patrol team.

Illegal pitsawing is likely to continue as long as its rate of return is higher than that of alternative activities, e.g. wage labour (Skage 1994), plus the cost of being apprehended. In this sense, illegal pitsawing must be seen as an economic activity with production risks.

In the past, in government controlled forests, the Forest Department (FD), which has now become the National Forest Authority (NFA), designated felling coupes (BFR management plan 1997-2007) of about 150 to 300 hectares for selective felling. However, currently, the NFA prefers selling previously felled trees by auction after computing their volume and determining their prices. This ensures that only mature trees are cut and that utilisation of the whole tree is calculated.

Budongo Forest Reserve

Budongo Forest Reserve is a moist tropical forest of approximately 825 km^2 in areas, where closed canopy forest covers 53.7% of the land and grassland forms the remainder. It was managed previously for timber production, particularly mahogany (Harris 1933, Howard 1991, Plumptre and Calvalho 1991, Bahati 1998). Today multiple management strategies to meet timber, animal and tourism interests are pursued (Herd and Langoya 1994).

BFR consists of Budongo, Siba, Busaju and Kaniyo-Pabidi forests. It is situated in Bunyoro Kingdom in the western part of the country in the districts of Masindi and Hoima with the largest part falling in the former. It occupies part of Bujenje, Bululi and Bilisa counties in Masindi and part of Bugahya in Hoima district. It lies to the North of Masindi-Butiaba road, approximately 39 km from Masindi town. The reserve is divided into eight Blocks, namely, Siba, Biso, Nyakafunjo, West Waibira, East Waibira, Busaju and Kaniyo-Pabidi. its geographical location is between latitude 1^{o}35' and 1^{o}45'N and between longitude 31^{o}18' and 31^{o}42'E.

Budongo forest was first gazetted in 1932 with an area of 502 33ha. An area of 52 785ha divided from the latest boundary management plans includes 2552ha traditionally regarded as part of Budongo Forest Reserve but has still to be gazetted.. An area of 52 785ha divided from the latest boundary management plans includes 2 552ha traditionally regarded as part of BFR but has still to be gazetted. Busaju and Kaniyo-Pabidi were originally local forest reserves managed by Bunyoro Kingdom Government. They were transferred to central Government under statutory instrument 1968 No.176. A large part of Kaniyo-Pabidi, North of the line between Lunkole and Kyabatwa hills has been jointly managed with forest and game products as part of Karuma Game Reserve. In practice, the first call was on relevant provisions of the Forest Act (chapter 246) before the interests of the game preservation and control act (chapter 226) were invoked.

MATERIALS AND METHODS

Illegal pitsawing is a notable practice in BFR, particularly in compartment 15 of Nyakafunjo block which is a Strict Nature Reserve (SNR). The study leading to this paper analyzed the financial implications of both abandoned and destroyed wood by pitsawers. It also compared the intensity of illegal pitsawing in the strict nature reserve and on the forest edge as well as the species and diameter classes of trees most affected.

Data collection

The survey was carried out using existing transects; square plots of 500 × 500m (25ha) were established at an interval of 50m from each other. A total of 40 plots were established, with 20 plots on the forest edge (50m from the boundary, i.e. the area surrounded by the community) and the other 20 plots inside the SNR. Sampling coverage of Nyakafunjo block was 11.7%. For every pitsawing site encountered, poles (cross poles, upright poles, pushers, rollers), unconverted (abandoned) logs and off-cuts had their top, mid and bottom diameters measured using a Vanier caliper, diameter tape and a linear measuring tape. The abandoned logs were graded in three different grades, namely, Premier, Standard and Recovery. The characteristics considered in grading are as shown in the Table 1.

TABLE 1 *Characteristics considered in timber grading*

Grade	Minimum length (centimeters)	Minimum Diameter (centimeters)	Defect Percentage
Premier (P)	4	60	10
Standard (S)	3	50	25
Recovery (R)	2	30	50

Source: NFA records, Budongo forest sector

Data analysis

Volume estimation was based on the measurement of diameters (top, mid and bottom) using Newton's formula,

$$V = \left[\frac{d1^2 + 4dm^2 + d2^2}{6x4} \right] \pi L$$

Where:
V = Volume
d1 = Top diameter
dm = Mid diameter
d2 = Bottom diameter
L = Log length

For the stumps and big abandoned logs, mid diameters were measured and volumes calculated using Huber's formula:

$$V = \left[\frac{dm^2}{4} \right] \pi L$$

Where:
V = volume
d = mid diameter
L = log length

Using current rates for a cubic meter of wood and for various classes of natural poles, the costs involved were calculated.

The revenues for calculated wood losses were attained using current prices set by the NFA, weighted in accordance with Todd's (2004) method for calculating reserve prices of tropical high forests. The revenues were discounted at an interest rate of 14% for a period of two years to give the present value of the lost revenues. An interest rate of 14% was used because the pitsawn trees were mature and ready for harvesting and marketing. The future values of revenue losses for the next five years were estimated by compounding, based on the assumption that illegality will continue at the same rate for the next five years (until 2011) since the demand for timber and other forest products has increased country-wide.

$$PV = \frac{FV}{(1 + r)^n}$$

Where:
FV = Future value at time = n in the future.
PV = Present value at time = 0
r = Interest rate
n = Number of years

Analysis of variance (ANOVA) was used to show the variation within the categories in which wood is lost. It was also used to show the variations in diameter classes of the trees cut by illegal pit sawyers at different pitsawing sites and the variation with in the diameter classes of the trees cut for platform construction at different pitsawing sites. The t-test was run to determine whether there was a significant difference in the wood lost inside the forest and on the forest edge.

RESULTS

Abandoned logs

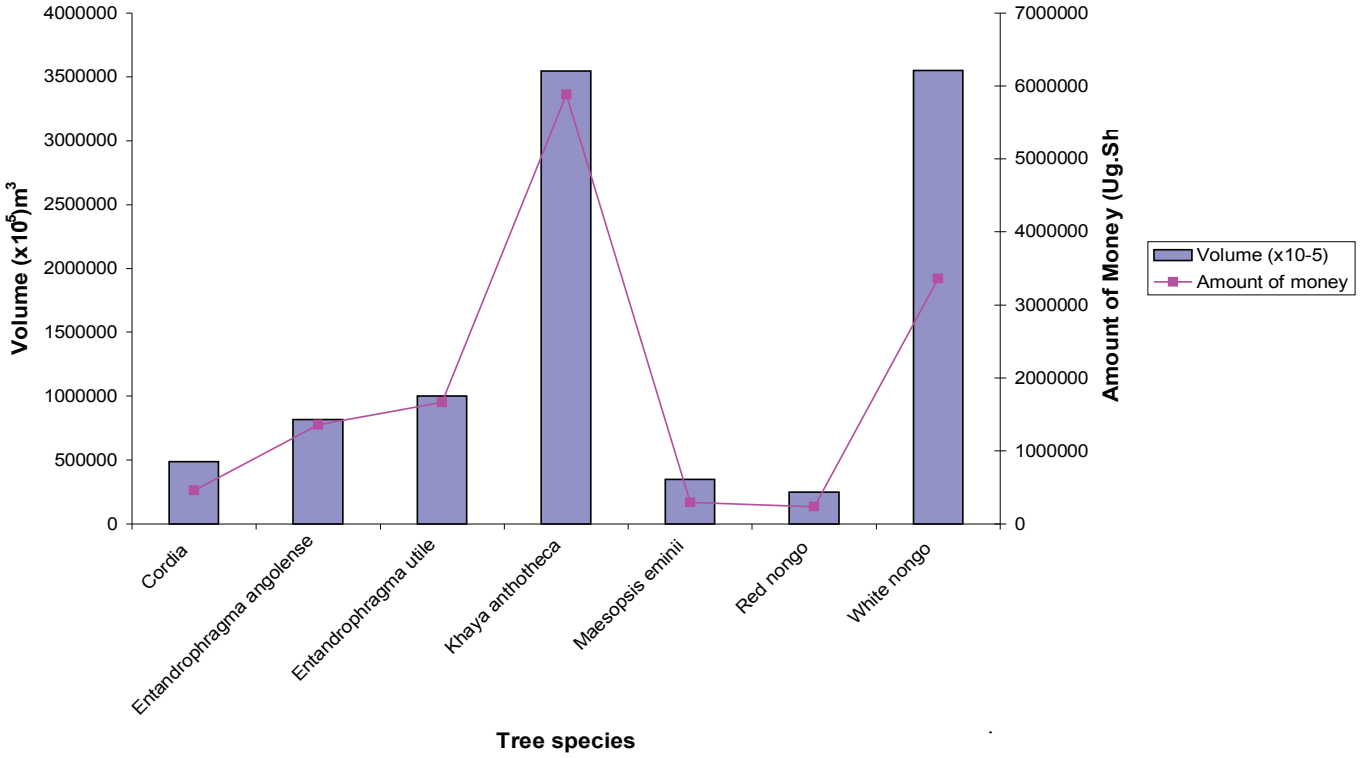
The total volume of abandoned logs was 269m^3 (round wood) with a value of UGX 38 292 908 (exchange rate at the time of study was UGX 1 740 to 1 US dollar) accounting for 62% of the total wasted round wood sampled. This amount was lost in a period of two years implying that on average, round wood worth UGX 19 146 454 is lost per year. When discounted at an interest rate of 14% for a period of two years, it gives rise to a Present Value (PV) of UGX 29 465 149. This amount compounded at the same interest rate (14%) for the next five years (assuming illegal pitsawing continues at the same rate for the next 5 years) gave a loss value of UGX 56 732 628 by the year 2011.

It was noted that of all the abandoned logs, 80% (215.3 m^3) were mahogany species (*Khaya anthotheca*, *Entandrophragma utile* and *Entandrophragma angolense*) which accounted for 30 983 905 million shillings when sold as round wood. Other species included *Albizia glaberrima* (40m^3, UGX 3 793 525), *Albizia zygia* (3.5 m^3 worth UGX 333 371), *Maesopsis eminii* (10m^3, UGX 844 582) and *Cordia millenii* species (25m^3, UGX 2 337 524) If the abandoned logs of Mahogany were to be converted into sawn timber, assuming recovery of 48%, 129m^3 of sawn timber worth 56 119 672 shillings would be obtained.

Estimated value of stolen logs

About 100m^3 (23% of the total wood loss) worth UGX 13 258 180 was estimated to have been stolen. This value discounted 14% for a period of 2 years gave a present value of UGX 10 201 739. Compounded for the next five years at an interest rate of 14%, the value loss of UGX 19 642 576 could be lost by the year 2011. Mahogany species still had the highest percentage in this category, 54% (54m^3 worth UGX 8 903 864). Other species included, *Cordia millenii* species (5m^3 worth 460,237), *Maesopsis eminii* (3.5m^3 worth 296 652), *Albizia zygia* (2.5m^3 worth 236 383) and *Albizia glaberrima* (36m^3 worth UGX 3 361 042) as shown in Figure 1.

FIGURE 1 *An estimate of the volume of wood and its equivalent monetary value lost as stolen logs*



Stumps

Stumps accounted for 12% of the total loss of round wood estimated at 53m^3 by volume, and worth UGX 6 869 758. Stumps were frequently at a greater height than the NFA permitted stump height of 0.3m, with some as high as 3 metres above the ground. This money was lost over a period of two years giving an average loss of UGX 3 434 879 per year. When discounted at an interest rate of 14%, a present value of UGX 5 286 056 was calculated as the loss being experienced. Compounding for the next five years produced a figure of UGX 10 177 849 implying that this money will be lost by the year 2011 if illegality continues at the same rate. Mahogany species accounted for 54% of the total stump volume with a total of 28.5m^3 worth 4 604 053 million shillings. Other species included *Albizia zygia* (2m^3 worth UGX 199 876), *Albizia glaberrima* (17m^3 worth UGX 1 643 181), *Cordia millenii* (3m^3 worth UGX 256 878) and *Maesopsis eminii* (2m^3 worth UGX 165 771).

Diameter variation within stumps

There was no significant stump diameter variation with in the pitsawing sites (P = 0.73, Fcal.0.12, Fcrit.4.96) as shown in Table 2. The variations in stump diameters between the different pitsawing sites were also not significant (P = 0.07, Fcal.2.64, Fcrit.2.98) suggesting that only big trees of more than 0.8m diameter were selected. The average diameter of the stumps was 1.23 metres which indicates the desire of pitsawyers to attain as many timber pieces as possible from the butt-end log.

Cross poles

Cross poles accounted for 1% (6.23m^3 worth UGX 562 030) of the total loss observed. Saplings were mainly used for this purpose with an average diameter of 0.28m. Celtis species (*Celtis Africana, Celtis adolfi-frederici and Celtis milbraedii*) were the most frequently used although others were also used, including *Acalypha ornata, Blighia unijugata, , Cordia milenii, Cynometra alexandrei, Erythrophleum sauveolens, Maesopsis eminii, Sapium ellipticum, Teclea nobilis and Tectona grandis.*

A total of UGX 562 030 was calculated to have been lost for a period of two years producing an average yearly loss

TABLE 2 *ANOVA of diameters of stumps*

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	0.005890909	1	0.005890909	0.12438336	0.731648531	4.964602701
Columns	1.251409091	10	0.125140909	2.64228267	0.070624223	2.978237016
Error	0.473609091	10	0.047360909			
Total	1.730909091	21				
ANOVA of diameters of cross poles						
Rows	0.00021913	3	7.3042E-05	1.98978434	0.124543	2.75054116
Columns	0.06759124	21	0.00321863	87.6811917	1.09E-38	1.725969
Error	0.00231263	63	3.6708E-05			
Total	0.07012299	87				
ANOVA diameters of upright poles						
Rows	0.005616234	9	0.000624026	1.10383864	0.361943	1.929689
Columns	0.040431222	21	0.001925296	3.40565344	3.6E-06	1.612115
Error	0.106846162	189	0.000565324			
Total	0.152893618	219				
ANOVA diameters of pushers						
Rows	0.03587522	4	0.0089688	1.106769	0.3588319	2.480322306
Columns	0.48534505	21	0.02311167	2.852028	0.00036566	1.683053267
Error	0.68070158	84	0.00810359			
Total	1.20192185	109				

NB: ANOVA: Two-Factor without Replication

of UGX 281 015. Discounting at a rate of 14% produced a present value of UGX 432 463 and when compounded at the same interest rate (14%) for a period of five years, it suggested that UGX 832 672 would be lost by the year 2011 if illegal pitsawing continues at the same rate for the next five years. There was no significant diameter variation with in the poles used as cross poles (P = 0.12, Fcal.1.99, Fcrit.2.75)(see Table 2). The average diameter of cross poles at all of the pitsawing sites was 0.17m, indicating that only poles are used for cross poles. Significant variations in cross pole diameters between the different pitsawing sites (P = 1.09E-38, Fcal.87.68, Fcrit.1.72) (Table 2) could probably be explained due to difference in the sizes of the pitsawing platform beds, where bigger platforms had more cross poles than smaller ones.

Upright poles

Upright poles contributed only 1% of the total loss calculated ($3.5m^3$) worth UGX 213 010. Compounding of the present value for five years produced a figure of UGX 315 583 as the money to be lost by the year 2011 if illegal pitsawing continues at the same rate. *Cynometra alexandrei* was the most frequently used species as upright poles (Figure 2). No significant variation in the diameters of upright poles was revealed. It was, however, found out that the variations in upright poles' diameters between the different pitsawing sites were significant (P = 3.6E-06, Fcal.3.41, Fcrit.1.61).

Pushers

Pushers accounted for only 1% of the total calculated wood lost trough illegal pitsawing. On average, UGX 103 198 was lost per year. Discounting at 14% for a period of two years gives UGX 158 815 as the present value which when compounded at the same interest rate for a period of 5 years amounts to UGX 305 785. It is predicted that by the year 2011, UGX 305,785 will be lost as pushers if illegal pitsawing continues at the same rate as it has been for the last two years. *Cynometra Alexandria alexandrei* and *Acalypha ornata* species were the most and least used as pushers respectively. This is probably due to its high tensile and compression strength with the ability to contain heavy weights of big logs exerted on them when rolling the logs up the platform beds. There was no significant variation in the diameters of pushers (P = 0.36, Fcal.0.009, Fcrit.2.48) between sites.

A comparison of the intensity of illegality in SNR and on the forest edge

More trees were pitsawn at the forest edge, however, a larger volume of wood was recorded to have been lost in the SNR (Figure 3) because the forest edge suffers heavy encroachment from the surrounding communities that need forest products for building poles, fire wood and poles for sale hence not giving the trees ample time to reach maturity.

FIGURE 2 *Tree species used as upright poles*

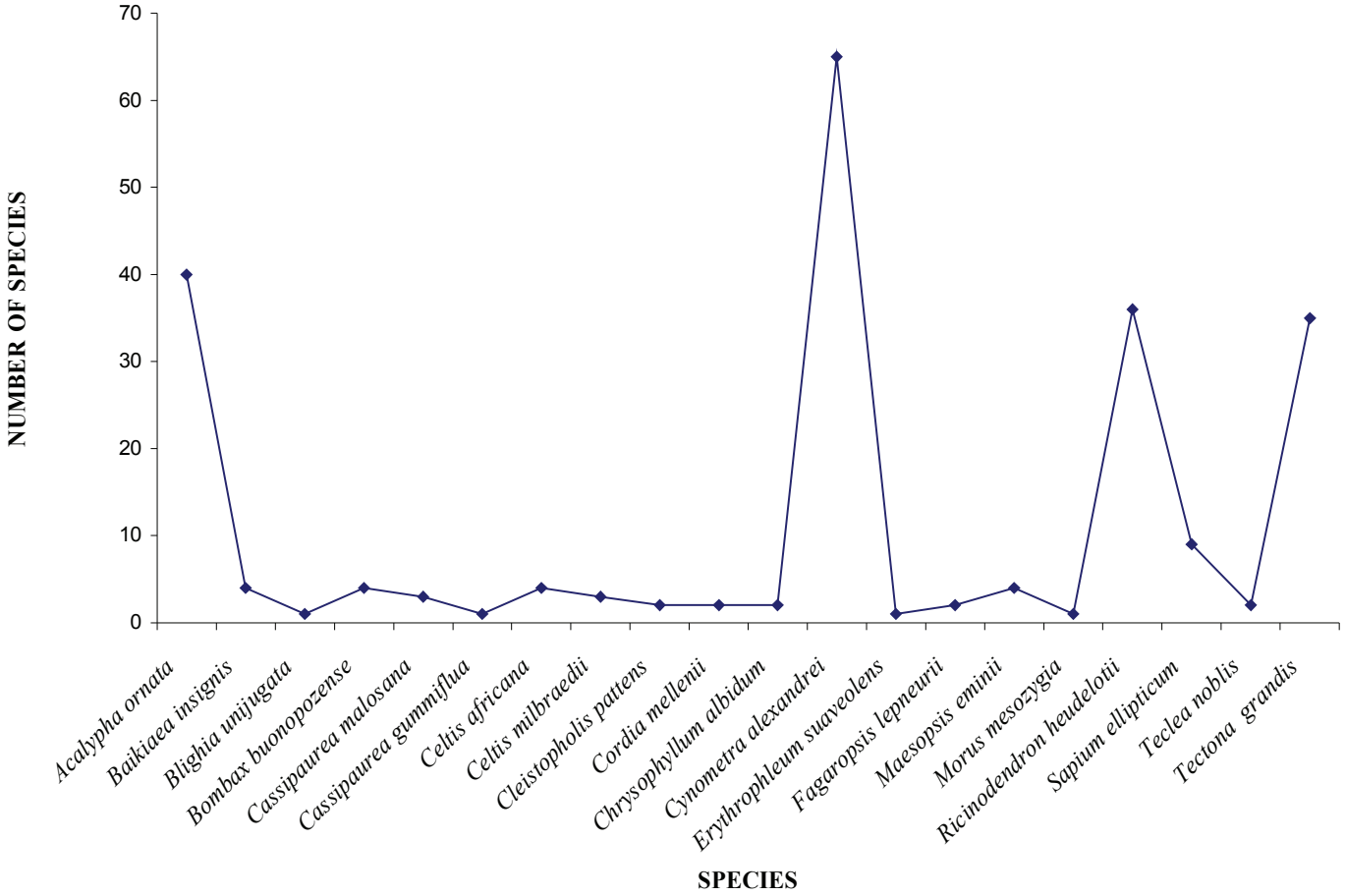


TABLE 3 *Relation between wood volumes lost in the SNR and on the forest edge*

t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	Variable 2
Mean	23.49634057	19.13829555
Variance	502.9724509	54.87848814
Observations	11	11
Pooled Variance	278.9254695	
Hypothesized Mean Difference	0	
df	20	
t Stat	0.611968362	
P(T<=t) one-tail	0.273726703	
t Critical one-tail	1.724718218	
P(T<=t) two-tail	0.547453407	
t Critical two-tail	2.085963441	

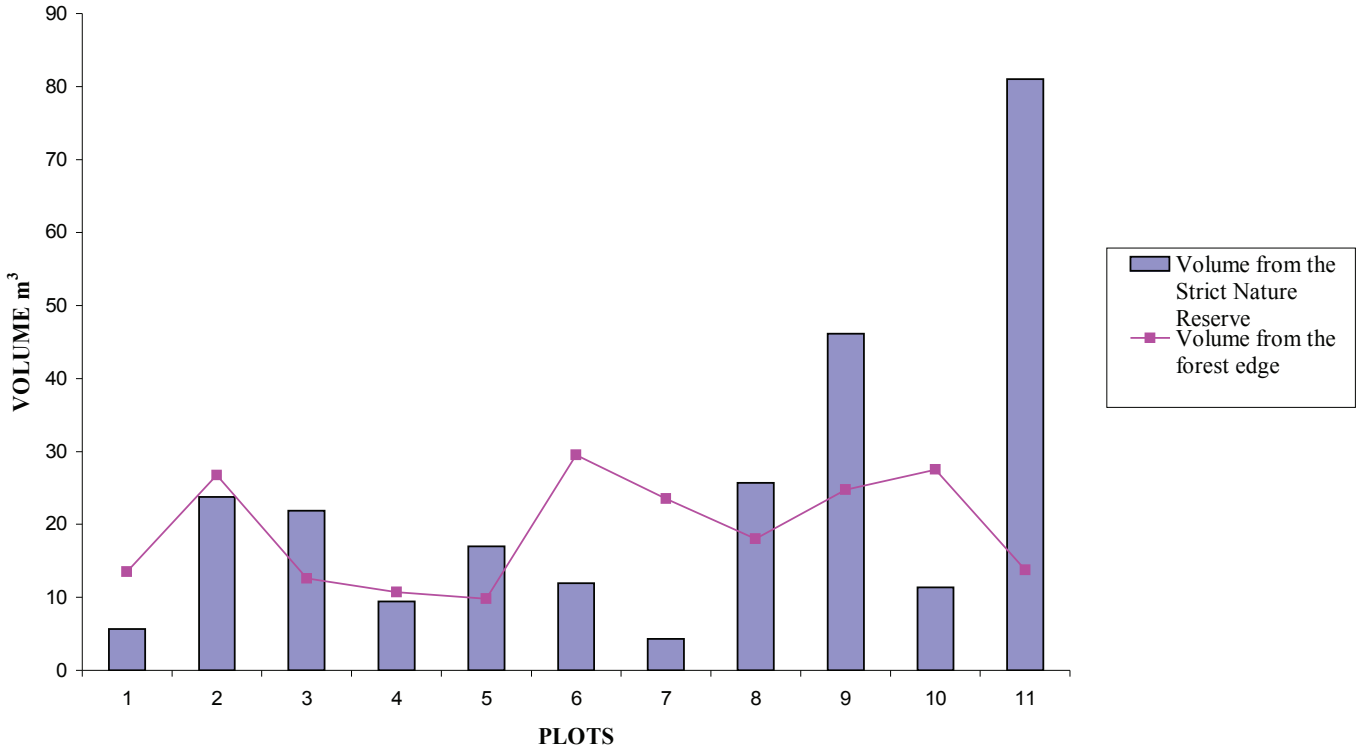
However, there was no significant wood volume loss between the SNR and the forest edge (Table 3).

Field observation suggested that the forest edge suffered more vegetation loss than the SNR due to encroachment by the surrounding communities especially people from Marram, Kanyege and Agidumani villages. Encroachment is one of the major challenges facing the BFR since part of it lacks the buffer and production zones that would shield it from encroachment.

Empirical observations of the ecological impacts

Some important ecological impacts of pitsawing were observed during field observations in Budongo Reserve.

FIGURE 3 *Wood volume lost in the strict nature reserve and on the forest edge*



They were as follows:

- Due to lack of supervision, some trees were felled close to the river /stream banks thus affecting stream/ river flow.
- Pits dug to aid pitsawing with the average dimensions of 2m length, 1m wide and 1m depth caused substantial damage to the vegetation cover.
- Pitsawyers made foot trails in the forest which later opened access for further forest users such as firewood collectors and hunters.

DISCUSSION

Abandoned logs, mostly of mahogany species, accounted for the highest total of wasted wood material. Logs are usually abandoned in fear of being arrested by NFA patrolling staff forcing pitsawyers to process only the butt-logs. (The practice is to move to another site more than 5km from the previous site). This practice also probably accounts for the very high stump heights discovered as it is thought that that illegal pitsawyers act haphazardly and rapidly in fear of being caught by NFA patrol men.

The fact that there was no significant stump diameter variation either within or between the pitsawing sites is an indication that pitsawyer are selective in the size of the trees they harvest; usually targeting only the largest trees.

Platforms are made from poles, namely the cross-poles, upright poles and the pushers on which the logs are pushed onto the platform. The cross poles accounted for 1% of the total loss observed. There was no significant diameter variation with in the poles used as cross poles. However, variation in cross pole diameters between the different pitsawing sites was significant, which was probably accounted for by the difference in the sizes of the pitsawing platform beds, with bigger platforms requiring more cross poles than smaller beds.

A number of species were used as cross poles but Celtis species (*Celtis Africana, Celtis adolfi-frederici and Celtis milbraedii*) were used most frequently possibly because of their high tensile static binding and compression strength to accommodate the heavy weights imposed on them. The upright poles also contributed only 1% of the total loss. Many species were used as upright poles with *Cynometra Alexandria* species being the most common. This is probably due to its high tensile and compression strength with the ability to contain heavy weights of big logs exerted on them during the pitsawing process.

CONCLUSIONS AND RECOMMENDATIONS

More trees were pitsawn at the forest edge as compared to the SNR, although a larger volume of wood was harvested in SNR as compared to the forest edge. The volume of wood lost as a result of illegal pitsawing is about 0.45m^{3}per/ha/yr worth about UGX 30,000/ha/yr. The wood loss is about a third of what the tropical moist forest is able to produce per hectare per year.

This study has revealed that the major reason for pitsawing originates from the general failure by the NFA to

effectively enforce forest regulations governing the SNR. The important policy recommendations drawn from these findings include:

- An urgent recruitment of field staff by NFA to work as forest guards entrusted with the role of forest protection and law enforcement.
- NFA should encourage pitsawyers and timber dealers to undertake timber tree growing activities their private lands. This will help to increase the supply of timber and reduce on the pressure on the central forest reserve.
- Functional working relations should be fostered and maintained between NFA and local communities around the central forest reserve so that the community actively participates in the management of the central forest reserve.
- There is a need for the government and NFA to identify alternative off-forest sources of income and livelihoods for the communities adjacent to the BFR. This strategy will help to reduce pressure and over dependency on the BFR.
- Given the fact that NFA is under-funded yet facing serious challenges of pitsawyers and encroachment, it is argued that the government should increase the budgetary allocation for the conservation and protection of BFR.

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